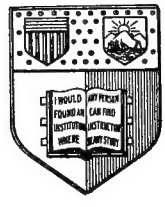
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A HISTORY OF BRITISH MAMMALS

BY

GERALD E. H. BARRETT-HAMILTON

B.A. (CANTAB.), M.R.I.A., F.Z.S.

WITH TWENTY-SEVEN FULL-PAGE PLATES IN COLOUR, FIFTY-FOUR IN BLACK AND WHITE, AND UPWARDS OF TWO HUNDRED AND FIFTY SMALLER ILLUSTRATIONS

DRAWN BY

EDWARD A. WILSON

B.A., M.B. (CANTAB.)

IN THREE VOLS.

VOL. I.—BATS

GURNEY AND JACKSON

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FOREWORD.

MR OLDFIELD THOMAS, F.R.S., of the British Museum of Natural History, the well-known authority on the mammals of the world, has kindly written the following appreciation of the forthcoming work :—

"In my official capacity at the British Museum I have constantly been asked for the name of a trustworthy book on the subject of British Mammals, and I have had to put off the enquirers with the promise of the present work, to the appearance of which every mammalogist, technical or amateur, has long been looking forward.

"To produce such a work is a difficult, though highly interesting task, which can only be efficiently completed in a large Museum. For this no one could be better suited than the author of the present work, who has for the last fifteen years worked constantly at the National Museum, not only on the British, but on all the European and Asiatic mammalia, and has written on them a considerable number of valuable scientific papers. He is therefore fully in touch with the literature of the subject, acquainted with all its recent advances, and in agreement with the principles of modern science. He has also had experience in the collecting and observing of mammals in the field—at home, in continental Europe, on the Seal Islands of Bering's Sea, in Morocco, Kamchatka, and on the veldt of South Africa."

PRELIMINARY ANNOUNCEMENT.

FOR many years Tomes and Alston's edition of Bell's *History of British Quadrupeds* has been the standard work on recent British Mammals, and although several attempts have been made to oust it from its place, not one can be said to have been entirely successful. Even the elaborately illustrated work of Mr J. G. Millais is, by its very price and size, placed outside the reach of the ordinary reader.

INCREASING INTEREST IN THE STUDY OF BRITISH ZOOLOGY. —The number of students of this branch of British natural history has greatly increased of late years, and their progress has been much impeded by the want of some more recent work than Bell's. In no other branch has the growth of knowledge or the change of view developed at a greater rate, and yet there is no work in existence offering in convenient form an authoritative summary of the information now available, with an indication of the lines upon which future research is most needed.

THE DESIGN OF THE WORK. — The present work is designed to meet the above want. Its author has had its production before him for over twenty years, and the book has been in his hands a labour of love. During this period he has been in constant touch (or correspondence) with all the leading local naturalists, and received from them much valuable assistance. He has consulted and critically examined all printed references to his subject in scientific and periodical literature, and made use of and referred to all notes of genuine value.

It was at first intended to produce merely a new edition of Bell's book, but as the work proceeded this was found impossible, so great has been the advance of knowledge, so complete

the change of view between 1874 (the date of Bell's last edition) and 1910. A few of Bell's paragraphs may, indeed, be utilized, wholly or partially, but the work as a whole will be found so completely altered as to leave hardly any trace of connection between the old and the new.

It may with truth be stated that no such work has ever been written, or attempted, in the English language. Its publication is bound to give an immense stimulus to the study of British Mammals.

Division into Sections.—The work will consist of three sections, dealing respectively with the Bats, the Land Mammals, and the Marine Mammals. Besides introductory chapters to the various orders, each genus and species will be the subject of an article complete in itself and divided into two portions, the one treating of the habits and life history, the other explaining the technical aspects of each animal.

Habits and Life History.—The habits will be fully traced, thus making the popular side of the subject very complete. The literary and historical aspect is not neglected, the author having made it a point to quote from the best British writers, with a view to illustrate the work of his predecessors and fellow-workers.

Technical Aspects.—The technical portions of each article will be ample, and contain authoritative details and explanations of matters which, although they admittedly appeal rather to the museum worker than to the field naturalist, yet must often be consulted by the latter, and are not at present available in any single work. Much of this part of the book will be based on original work of the author, and it goes without saying that a treatise of this character could emanate only from one who has probably had, in his own particular line, a unique experience of combined work both in the field and in the museum, and whose studies on European Mammals have given

him an exceptional knowledge and understanding of those which occur in the British Islands.

DISTRIBUTION, ETC.—The local names are being treated somewhat fully, and it is intended to include a full account of the geographical relationships and distribution, individual variation in colour, size, or form, with descriptions, measurements, and keys for distinguishing all doubtful species.

ILLUSTRATIONS.—No expense shall be spared in regard to illustrations. These are being drawn by Dr Edward A. Wilson, a trained naturalist as well as a gifted artist, who is already well known for his beautiful pictures of Antarctic life. The large numbers of explanatory or quasi-technical drawings will be unique. The reproduction of the coloured and black and white drawings into half-tone and line blocks is being entrusted to Messrs Hislop & Day, Edinburgh.

TYPOGRAPHY AND PAPER.—The type chosen for both parts of the work has been carefully selected, the smaller being used in the technical and the larger in the popular section. To ensure permanency, specially manufactured paper made from pure rags will be employed, that for the text being supplied by Messrs Alex. Cowan & Sons, Edinburgh, and that for the plates by Messrs John Dickinson & Co., London.

FORM OF PUBLICATION.—The work will be published in about twenty-four monthly parts, at the price of 2s. 6d. each net. Part I. will be ready on 18th October 1910. When completed, the whole will form three volumes extra royal 8vo, bound in buckram, gilt top, fore and under edges uncut. In issuing the Parts it is impracticable to arrange the coloured and black and white plates in proper order, but a detailed list of instructions for placing will be inserted in the concluding Part, which will also contain Title Pages, General Introduction, Contents, and Index.

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[Parti-coloured Bat (non-British).]

Genus *Myotis.*

Daubenton's, or the Water Bat.

[Rough-legged Water Bat (non-British).]

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Hooded Seal.
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With 250 Line Drawings, including Maps.

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BATS.

Sub-order MICROCHIROPTERA.

INSECT-EATING BATS.

CHIROPTERA.

BATS.

Sub-order MICROCHIROPTERA.

INSECT-EATING BATS.[1]

The twelve British species are all included in the great sub-order of insect-eating bats or *Microchiroptera*. They fall into two families—the *Vespertilionidæ*, or typical simple-faced, and the *Rhinolophidæ*, or horseshoe-nosed bats.

History:—British naturalists have not been quick to distinguish the various species, and even at the present time there are few who boast expert knowledge of not the least interesting group of British mammals. Appreciation of distinctions grew, in fact, so slowly, that for original descriptions of our native species we are in every case indebted to continental naturalists, the chief honours being shared by Daubenton of France and Leisler and Kuhl of Germany.

Of British writers, Merrett, in his *Pinax* (1660), and Ray, in his *Synopsis* (1693), made no attempt to diagnose species, but Albin, in his *Natural History of Birds*[2] (1740), gave a place to three—the "small common sort," the Double-eared (namely,

[1] For many references to the literature of these animals, see N. H. Alcock's paper on the vascular system of bats in *Proc. Zool. Soc.* (London), 1898, 58. Dobson's *Catalogue of the Chiroptera in the Collection of the British Museum* is still the main authority for the order as a whole, but will probably be replaced by degrees by Knud Andersen's review of the order now in progress. G. S. Miller's (jun.) "The Families and Genera of Bats" (*Bull.* 57, *U.S. National Museum*, 29th June 1907), is also invaluable, and has been largely drawn upon for the purposes of this chapter. Since my account of British Bats was written, I have received W. L. Hahn's important American paper, "Some Habits and Sensory Adaptations of Cave-inhabiting Bats" (*Biol. Bull. Marine Biol. Lab.*, Woods Holl, Mass., xv., June to November 1908, 135-193).

[2] iii., 95.

the Long-eared), and a flying fox, the latter, of course, exotic. Pennant in his earlier editions (1766 and 1768) recognised only two, which he called the Short-eared and the Long-eared, but in 1776 he added the Great and the Horseshoe, and substituted the Common for the Short-eared. He had taken a similar course in his *Synopsis Quadrupedum* (1771), wherein these four are definitely mentioned as British, but the Serotine, Pipistrelle, and Barbastelle are noticed as occurring in France. His knowledge of all British species, except the "Horseshoe," had evidently been derived from Gilbert White, who mentions "the great large bat" in his twenty-sixth letter, written on the 8th December 1769, and who, subsequently, in September 1771, devoted a complete letter to it as *Vespertilio altivolans*. In his eleventh letter, dated 9th September 1767, he had noticed the common *Vespertilio murinus*[1] and the *Vespertilio auribus*, but at this point his knowledge appears to have ended. More light came from Montagu, who in 1808 distinguished the two Horseshoes, and from Sowerby, who between 1804 and 1806 detected the Barbastelle as a British species; but Bingley in 1809 and Pennant in 1812 were able to enumerate only half the species now catalogued. Montagu's name *minutus*, given to the Lesser Horseshoe, still stands as the first technical name attached to the small British sub-species. Thenceforth progress again lagged. Donovan in 1820 omitted the Barbastelle; as did Gray[2] in 1826, together with Leisler's and the Water Bat, but brought up the British list to ten by the help of the Pygmy. Fleming in 1828 reinstated the Barbastelle and the Water Bat, the latter under the name of *emarginatus;* but it was not until the year 1835 that the first complete list appeared in Jenyns' *Manual*. This naturalist had previously corrected a notable error of British students—namely, the confusion of the Pipistrelle, the Common Bat of England, with the Mouse-ear, the "Common Bat"[3] of continental writers. He still, however, retained the latter in his list, and added the Particoloured Bat, both animals having undoubtedly entered the

[1] Called "the little bat" in letter xxvi. of 8th Dec. 1769.

[2] "A List of the Species of *Vespertilionidæ* found in Great Britain," *Zoological Journal*, ii., 108-110, 1826.

[3] *Myotis myosotis* (Bechstein).

British area. Two others, the Pygmy Bat of Leach and the Lesser Long-eared of Jenyns himself, were based on errors of identification, and have since been reunited with the Pipistrelle and the typical Long-eared. Jenyns' list therefore included sixteen species, amongst which were all those now recognised.

Two years later Bell, by the separation of the Notch-eared from Daubenton's, swelled the British list to its maximum of seventeen species, but in 1838 MacGillivray, by the suppression of the Pygmy and Lesser Long-eared, reduced it to fifteen. It has since dwindled to its present dimensions, the few specimens of the Mouse-ear and of the Parti-coloured Bat captured in Britain having been either escaped captives or stragglers from across the Channel, while the inclusion of the Notch-eared was an error due to confusion with Daubenton's.

Classification and Nomenclature:—The present work has nothing to do with general relationships, and, although care has been taken to follow the most natural grouping, for the present purposes the various British genera may be regarded as isolated and unconnected. Here, again, knowledge has found her way blindly, step by step, and those now best qualified to judge reverse Dobson's dictum of 1878 that the Horseshoes are the highest of their order, and, amongst British bats, have transferred the long-winged members of the genus *Nyctalus*, the high-flying swifts of their kind, to the head of their tribe, with *Myotis* as the most primitive vespertilionid genus, and the family *Rhinolophidæ* as of still lower organisation.

So late as 1874, three authorities no less weighty than Alston, Bell, and R. F. Tomes, united in one genus such dissimilar animals as the thirty-four toothed Noctule and Pipistrelle with the thirty-two toothed Serotine. The remainder of Bell's arrangement was in accordance with modern ideas of relationships, but, the rules of nomenclature not yet having crystallised into definite shape, his names of genera and species were applied with what would now be considered deplorable inaccuracy. The researches of Mr Miller resulted accordingly in much re-sorting of names, the elimination of *Scotophilus* and *Vesperugo*, the transference of *Vespertilio* from the thirty-eight toothed to the thirty-two toothed bats, and the reinstatement of the long and

unjustly forgotten *Pterygistes*, *Pipistrellus*, and *Myotis*. Yet so great has been, until recently, the general ignorance of the mammalian literature of the past, that it was left to Dr Andersen in 1908 to show that the Noctule and its congeners must be assigned to the genus *Nyctalus* hitherto associated with the fruit bats. Thus *Nyctalus* replaces *Pterygistes* with almost confusing celerity. The changes effected, although in themselves sufficiently violent and for a time inconvenient, are likely to be as permanent as any other system of nomenclature, and have now been, with exceptions as to details, accepted by the majority of systematic zoologists. We thus find the vespertilionid bats apportioned to six genera, viz. :—*Nyctalus* with two species; *Pipistrellus* with one; *Vespertilio* with one; *Myotis* with four; *Barbastella* with one; and *Plecotus* with one. The *Rhinolophidæ*, with one genus (*Rhinolophus*) and two species, remain as before.

The present aspect of our study cannot but at first sight appear pedantic; and the writer would be fortunate who could avoid it altogether. But there is no excuse for neglecting details, even of nomenclature, and each change may be welcomed as one step more toward such finality as is possible to human institutions.

Structure:—For a proper appreciation of the specific and generic characters of bats, a thorough acquaintance with the form of their ears and wings and the shape and number of their teeth is necessary. In acquiring this, the diagram (Fig. 1) will be found useful.

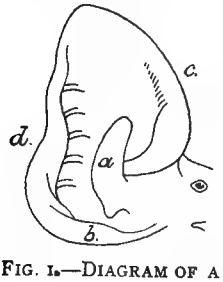


FIG. 1.—DIAGRAM OF A BAT'S EAR.

a, tragus;
b, antitragus;
c, anterior margin;
d, posterior margin.

In all British bats except the *Rhinolophidæ* there springs from the inner or anterior margin of the ear a process called the tragus; it has the appearance of a second or inner ear. At the base of the outer or opposite margin, and especially conspicuous in the *Rhinolophidæ*, arises a lobe known as the antitragus. The shape and size of these two is of some importance in classifying and identifying these animals (Fig. 3), but great caution should be observed in the examination of these parts in preserved specimens, the ears of which may alter considerably. In a series of

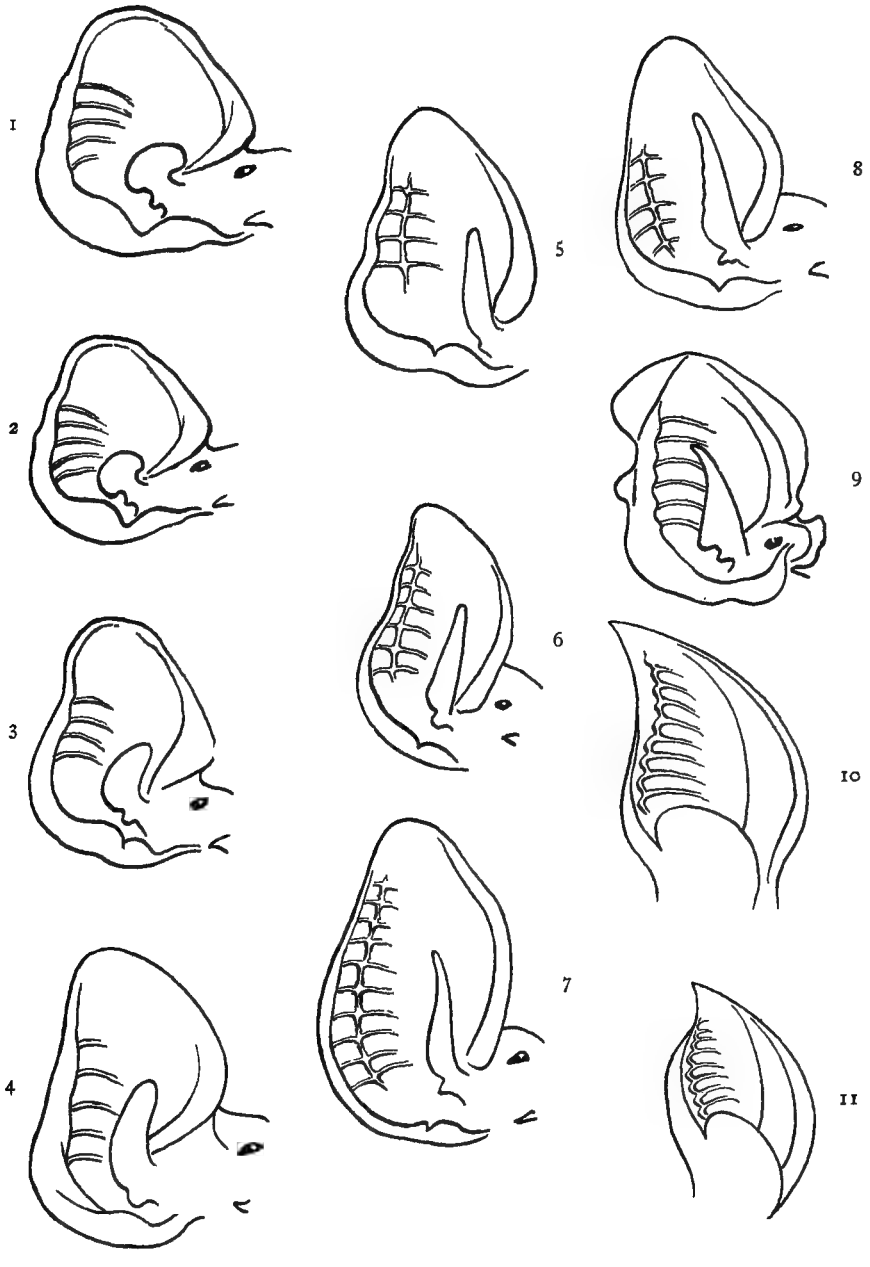


FIG. 2.—EARS OF BRITISH BATS, EXCEPT *Plecotus auritus* (diagrammatic).

1. *Nyctalus noctula.*
2. *N. leisleri.*
3. *Pipistrellus pipistrellus.*
4. *Vespertilio serotinus.*
5. *Myotis daubentoni.*
6. *M. mystacinus.*
7. *M. bechsteini.*
8. *M. nattereri.*
9. *Barbastella barbastellus.*
10. *Rhinolophus ferrum-equinum.*
11. *R. hipposideros.*

six Pipistrelles in the Dublin Museum, the ears have shrunk to little more than half their natural size, thus completely changing their appearance.[1] Some such circumstance probably accounts for an error in Dobson's description of the ears of the Barbastelle.

Even more important is the wing (Fig. 3), which consists of a thin cutaneous membrane. This, in its complete development,

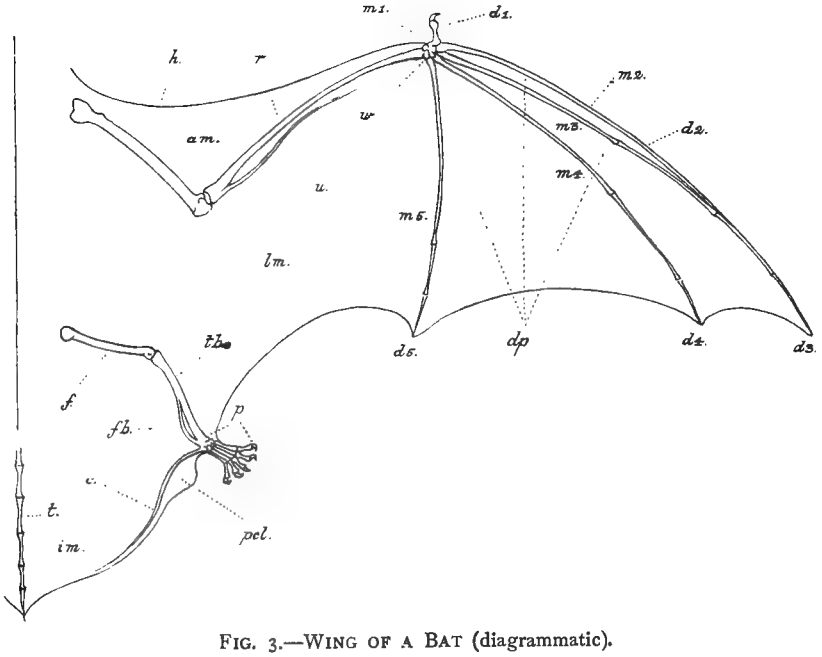


FIG. 3.—WING OF A BAT (diagrammatic).

Membranes:—*am*, antebrachial; *lm*, lateral; *im*, interfemoral; *dp*, dactylopatagium; *pcl*, post-calcarial lobe. *Skeleton*:—*h*, humerus; *r*, radius; *u*, ulnar; *w*, wrist; *d* 1, 2, 3, 4, 5, digits 1, 2, 3, 4, 5; *m* 1, 2, 3, 4, 5, metacarpals 1, 2, 3, 4, 5; *f*, femur; *tb*, tibia; *fb*, fibula; *p*, foot; *c*, calcar or spur; *t*, tail.

arises at the neck at each side, and, including within its substance, somewhat like the ribs of an umbrella, the four limbs and the tail, forms an uninterrupted parachute or patagium around the body. The greater portion of this parachute is supported by the forearms. In order to maintain it there is an immense development of each hand or manus, in which the five fingers or digits are always present. The basal joints of the digits are not homologous with the finger-joints or phalanges of other

[1] See Andersen, *Ann. and Mag. Nat. Hist.*, Nov. 1906, 372-373.

mammals, but rather with the metacarpals or bones of the hand. In the first digit, thumb or pollex, there are two phalanges. Being always partly free from the wing, and armed with a claw, it is used by the animal, when not flying, for purposes of climbing, but not, as often stated, in locomotion. In the remaining digits the phalanges are as follows :—

Digit.	Phalanges.			
II.	1	(*Vespertilionidæ*)	nil	(*Rhinolophidæ*)
III.	3	,,	2	,,
IV.	3	,,	2	,,
V.	3	,,	2	,,

(The terminal phalanges are often cartilaginous.)

The modifications in length or development of the digits materially affect the length and strength of the wing and the powers of flight.

As in other mammals, the hand is attached to a limb consisting of a wrist or carpus with six small bones, a forearm composed of a rudimentary ulna and a long curved radius, and of a humerus or upper arm. These constitute the complete framework of the wing. The length of the forearm is sufficiently constant in individuals of the same species to afford in many cases a satisfactory guide to their identification. The humerus is peculiar in the large size of the trochiter and trochin or tuberculum majus and minus.

The shoulder girdle and sternum are often much modified, especially in the *Rhinolophidæ*.

The hind-limb consists of the parts usual in mammals. It is so rotated outwards by attachment to the wing, that the knee points backwards. The foot is armed with claws and used for suspension and progression otherwise than in the air. A remarkable, elongated, cartilaginous process, the calcar, arises from the inner side of the ankle-joint, and helps to support the posterior margin of the interfemoral membrane, or that portion of the wing which occupies the space between the legs and the tail. The points of attachment of the interfemoral membrane to the tail and, especially, to the legs are diagnostic characters, as is also, when present, a lobe which has its point of origin over the calcar, and is known as the post-calcarial lobe.

A third and smaller extension of the flying integument, the antebrachial membrane, is stretched in front of the humerus and the forearm. The wing itself may be divided, for purposes of description, into two parts, viz., the lateral membrane, lying between the leg and fifth digit, and the dactylopatagium, or part directly borne by the fingers.

A comparative study of the wing in young and old bats of both sexes, as well as in the various species and genera, is necessary. Bats are born with a high development of the organs of attachment, the hind claws and thumbs, but the wings, which make their appearance late in the development of the embryo, are still quite small at birth, and, even when the young begin to fly, differ in their proportions from those of the adult (Plate II., Fig. 2, p. 16). Immaturity may, however, always be recognised by the imperfectly ossified joints of the digits, which when fully adult appear as definite knobs or swellings traversed only by a single indefinite line (Plate I.). In immature specimens, on the other hand, the imperfect ossification is shown by the presence of one or two small bones, the epiphyses, which lie between the two joint-heads and give the appearance of at least two distinct transverse lines between them. The process of ossification is evidently of variable duration. I have inspected a young Whiskered Bat and Pipistrelle, with the phalanges fully developed as regards their length, though not as regards their joints, on 26th July and 9th August respectively; but the process of fusing the epiphyses had not been completed in some Lesser Horseshoes examined by Mr T. A. Coward in January, nor in another specimen of the same species, which came under my own notice in the March following.

Amongst adults of British bats, the females are usually the larger,[1] but, after deducting all differences due to age and sex, there still remains a considerable amount of variation in size and proportions, the cause of which is not understood. It is not, however, sufficient to lessen the importance of the wing as a feature of high diagnostic value.

The actual dimensions of the various species are shown

[1] This is not a universal characteristic of the *Chiroptera*, since in some fruit-eating bats the male is the larger sex.

by the following table, from which it will be seen that, as regards size, they fall into two groups, viz., three large bats—the Noctule, Serotine, and Greater Horseshoe—in which the forearm measures about 50 mm., and the remainder, with a forearm varying between 30 and 42 mm. Leisler's and Bechstein's are the largest, and the Pipistrelle is the smallest of the latter group.

TABLE OF AVERAGE DIMENSIONS:—

	Head and body.	Forearm.	Tail.	Lower leg.	Foot.	Longest digit.	Metacarpal III.	Metacarpal V.	Expanse.
Nyctalus noctula									
5 to 7 males	77·5	50	49·5	17·5	12	91·5	48·25	38	[360]
7 to 8 females	77	51·5	[49]	17·5	12	92·5	50	40	[375]
N. leisleri									
10 of both sexes	[59·5]	42	[41]	17	8	[72·5]	38·5	31·5	[300]
Pipistrellus pipistrellus									
9 to 12 males	42	29·5	31·85	[10·5]	5·65	50	25	25	[208]
5 to 11 females	43·35	30·28	30·5	11·36	7·14	50	25	25	213
Vespertilio serotinus									
7 males	73	52·8	52·5	20·8	..	86·5	47	43·5	368
11 of both sexes	74·2	52·1	52·3	20·8	10·5	86·6	47	44	360
Myotis daubentoni									
19 of both sexes	45·5	36·5	33·5	16·4	9·1	59·8	32·2	30·2	223·8
M. mystacinus									
6 males	[46]	34	[32]	15·5	[7·5]	[53·5]	[29]	[28]	[228]
M. bechsteini									
5	[55]	41	[35]	19·5	(?) 8-10	64	33·5	33	[250]
M. nattereri									
15 females	45·1	39·4	37·6	16·5	8	65·6	33·1	33	[274]
Plecotus auritus									
10 males	48·2	37·5	41·6	17·3	8·8	62·2	31·3	30	[255]
17 females	45·7	38·8	42·2	18·3	8·8	65	32	30·9	
Barbastella barbastellus									
6 males	[48]	37·6	43·4	18·6	6·7	66·4	34·8	32·5	[250 – 260]
Rhinolophus ferrum-equinum									
11 males	63·2	53·6	32	24·5	11·2	83·4	36·4	38·9	334·6
5 females	65·8	54·5	33·2	25·3	11·8	85·8	36·2	40·5	[350]
R. hipposideros	[38]	37·5	25·2	17·5	8	[52]	23·5	26·5	[245]

Note.—The square brackets indicate that the enclosed figures are based on measurements of less than five specimens.

In order to compare the proportions of the species, the dimensions have in a second table been reduced to terms of their respective forearms, the reason for selecting the forearm being that it is probably the most stable feature of the wing. Thus in the eleven British bats (omitting Bechstein's, for which no series is available), the forearm bears the fairly

constant relation to the total expanse of about .14, and varies only about .02 on either side of this mean, from .13 in the long-winged Noctule to .15 or .16 in the short-winged Horseshoes and in the Water Bat. Another proof that in this respect variation is not great is to be found in the fact that in three species of about equal size, but dissimilar proportions, such as the Noctule, Serotine, and Greater Horseshoe, the forearm is almost of identical length.

The proportions which the length of the forearm bears to the total expanse and to the length of the head and body are approximately as follows:—

	Total expanse.	Head and body.
Nyctalus noctula	.13	.6
„ *leisleri*	.14	.7
Pipistrellus pipistrellus	.14	.7
Vespertilio serotinus	.14	.7
Myotis daubentoni	.16	.8
„ *mystacinus*	.149	.7
„ *bechsteini*	.16	.7
„ *nattereri*	.14	.8
Plecotus auritus	.14	.7
Barbastella barbastellus	.14	.7
Rhinolophus ferrum-equinum	.15-.16	.8
„ *hipposideros*		

The following table shows that, of the vespertilionid bats, *Plecotus* and *Barbastella* excel in length of tail, a feature combined with exceptional length of lower leg and denoting a capacious interfemoral membrane. The remaining species do not present many differences in the former respect, but in *Nyctalus noctula* and *Pipistrellus* the lower leg is shortest. The foot is longest in *Myotis daubentoni* and *N. noctula*, and shortest in *Barbastella*. The expanse is greatest in *Nyctalus*, *Pipistrellus*, *Vespertilio*, and *Myotis nattereri* in the order named, and least in *M. daubentoni*. A narrow wing is indicated in *Nyctalus*, and less so in *Vespertilio* and *Barbastella*, by the elongated third metacarpal, considerably longer in each case than the fifth. The converse is the case in *Pipistrellus* and *M. nattereri*, in which the two metacarpals are about equal. *Barbastella* appears to possess the most ample wing, every part of it being exceptionally developed, although the foot is small.

TABLE SHOWING RELATION OF GENERAL DIMENSIONS TO LENGTH OF FOREARM:—

	Forearm.	Tail.	Lower leg.	Foot.	Longest digit.	Metacarpal III.	Metacarpal V.	Expanse.
Nyctalus noctula								
7 males	100	99	35	24	183	96	76	[720]
N. leisleri								
Both sexes	100	[97]	40	19	[172]	91	75	[714]
Pipistrellus pipistrellus								
12 males	100	108	[35]	19	169	84	84	[705]
11 females	100	100	37	23	165	82	82	703
Vespertilio serotinus								
10, both sexes	100	100	39	20	166	90	84	690
Myotis daubentoni								
13 males, 6 females	100	91	44	25	163	88	88	613
M. mystacinus								
6 males	100	..	45	[22]	[157]	[85]	[82]	..
M. bechsteini								
5	100	[85]	47	[19]	154	81	80	[605]
M. nattereri								
15 females	100	95	42	20	166	84	84	[695]
Plecotus auritus								
10 males	100	111	46	23	166	83	80	[680]
17 females	100	109	47	21	167	82	79	
Barbastella barbastellus								
6 males	100	114	49	18	176	92	86	[678]
Average (excluding *M. bechsteini*)	..	101	42	21	168	87	81	688
Rhinolophus ferrum-equinum								
11 males	100	60	46	21	155	66	72	624
5 females	100	61	46	22	157	67	74	[642]
R. hipposideros	100	67	47	21	[139]	63	71	[653]

The few figures available for *M. bechsteini* indicate an exceptional bat; short-tailed, but with long lower leg and broad short wing.

The *Rhinolophidæ* are markedly different, being characterised by an exceptionally short tail and third metacarpal. The fifth metacarpal is also short, but longer than the third. The expanse is poor, the wing short and broad with poorly developed interfemoral, but large antebrachial, membrane. The lower leg is well developed, the foot moderately so, the longest digit below the average.

Although naturally most at home on the wing, all the

vespertilionid bats—statements to the contrary notwithstanding—walk well, the sequence of their movements being that typical of quadrupedal locomotion. The Horseshoes alone are unable to make even a pretence of walking, and when on a flat surface, lie prone and helpless, their feebleness in this respect, since forearm, leg and foot are all well developed, being probably due to interference with the action of the forearm by their well-developed antebrachial membrane.[1] In spite of this, they readily climb backwards, by means of their feet and thumbs, up an incline, no matter how steep, and have no difficulty in taking wing from a flat surface, springing with surprising agility into the air, even from narrow or cramped surroundings. But, although no healthy British bat usually finds any difficulty in taking flight from a flat surface, it is possible that some individuals, perhaps after a heavy meal, may at times lack the necessary vigour; and all require lateral space for a forward jump and expansion of the wings. In climbing, the free tip of the tail is, in the vespertilionid bats, used as a kind of extra limb, and with it the inequalities of a rough surface are sought and held. In traversing the wires of a cage, the extended tail acts as a support like the stiffened rectrices of a woodpecker or tree-creeper, and even in horizontal progression it assists in throwing forward the body, being brought into contact with the ground on either side alternately in correspondence with the action of the feet. There is no evidence that the feet are ever used to aid in catching or holding the prey, but their variable proportions in the different species, from relatively largest in the Water Bat and Noctule to particularly small in the Barbastelle, must have some meaning, and need explanation. The thumbs might easily be used for holding or securing food, as they are in the fruit bats and in a berry-eating bat of Jamaica,[2] but I know of no evidence on this point, except in the case of a captive Natterer's Bat.

Dentition:—Young bats, except the *Rhinolophidæ*, are born with a complete milk-dentition, the function of which is to enable them to hold on to their mothers' nipples. These teeth differ

[1] As in other bats which walk poorly; see Dobson, *Catalogue of Chiroptera*, 466.

[2] *Phyllonycteris sezekorin* of Grundlach and Peters, as observed by Osburn, *op. cit. infra*, p. 22.

both in number and form from those of the permanent dentition. They are homodont, slender, sharply recurved and cusped, and cannot by their shape be divided into the ordinary divisions found in the adult—incisors, canines, premolars, and molars—but rather resemble the teeth of seals and cetaceans. They are weak and insignificant, and may persist in the edges of the alveoli until the permanent teeth are nearly grown;[1] their number for each species is not known, but in *Myotis* it is—

$$mi\ \frac{2-2}{3-3},\ mc\ \frac{1-1}{1-1},\ mpm\ \frac{2-2}{2-2}=22,$$

a combination which probably represents the maximum in correspondence with the high number of the teeth of the permanent dentition in this genus.

The permanent **teeth** consist, as in other mammals, of four kinds—incisors, canines, premolars, and molars. The cheek-teeth are acutely cusped, with a pattern more or less W-shaped. They vary in the different genera from thirty-eight in *Myotis* to thirty-two, as in *Vespertilio* and *Rhinolophus*. In most genera one or more of the teeth are so minute as to be functionless, difficult to find, and indeed they sometimes drop out of the jaw of the adult animal, so that the total, as given in the technical formulæ, is often deceptive to the student. The molars, the last three teeth in either jaw, are not affected by this reduction, neither are the canines at the other end of the cheek-series, nor, except in the *Rhinolophidæ*, the incisors. The teeth, therefore, which most call for careful study are the premolars, and they, fortunately, are easily recognised, since they are all the cheek-teeth between the last three (the molars), and the first, the conspicuous canine.

If we accept the current view of evolutionists, that the tendency of mammalian dentition lies towards reduction in the numbers of individual teeth, then the genus *Myotis* possesses the lowest type of dentition, the full formula in this case being—

$$i\ \frac{2-2}{3-3},\ c\ \frac{1-1}{1-1},\ pm\ \frac{3-3}{3-3},\ m\ \frac{3-3}{3-3}=38.$$

[1] For further details see L. F. E. Rousseau, "Mém. Zool. et anatomique sur la Chauve-Souris commune," etc., in Guerin's *Mag. de Zool.*, 1839, pl. 7; also Wilhelm Leche in Lund's *Universitets Års-skrift*, xii., 1-47, 1876, pls. 1 and 2 (analysed in *Archiv für Naturgeschichte*, i., 1877, 353-364), and xiv., 1-37, 1878, pls. 1 and 2.

This represents a very near approach to the typical complete dentition of the higher mammals, from which it appears to have receded, by the loss of one pair of upper incisors and of a pair of premolars above and below. Further reduction is foreshadowed by the small size of the first two upper premolars, especially the second upper, while the tendency is visible, although less markedly so, in the second lower premolar. Ascending the scale, we find *Plecotus*, having dropped a pair of upper premolars, with *pm* $\frac{2-2}{3-3}$ and a total of thirty-six teeth. In *Pipistrellus*, the next highest, a pair of lower premolars has vanished (both remaining pairs being quite small), and the formula is *pm* $\frac{2-2}{2-2}$, total thirty-four. *Barbastella* and *Nyctalus* have also a total of thirty-four, but in the latter the anterior upper premolar has become rudimentary, and the corresponding lower one is much reduced in size. In *Vespertilio* the former tooth has entirely disappeared, reducing the total to thirty-two, all of which are functional. In *Rhinolophus* the number is again thirty-two, but in this case the premolars are $\frac{2-2}{3-3}$, with the anterior upper and central under often rudimentary: the incisors, $\frac{1-1}{2-2}$, differ in number and arrangement from those of the vespertilionid bats; the upper ones are quite minute and functionless.

The missing teeth required to complete the typical mammalian dentition of forty-four have usually been taken as upper incisor 1 and premolar 1 in both jaws, the next to disappear being either premolar 2 or 3. Mr Oldfield Thomas, however, gives good ground for regarding the missing premolar as 2.[1] The posterior molar of both jaws is reduced in size, but it is present in all British species.

The **shape** and **form** of the teeth will be best understood by a reference to the diagrams representing the dentition of each species. The premolars resemble the simple canines, but are conspicuously smaller; the last is always much the largest, and is double rooted.

[1] *Ann. and Mag. Nat. Hist.*, April 1908, 346-348.

The crown pattern of the upper molars, often reduced in size from behind forwards, is formed by three main cusps—the inner anterior (the protocone), the outer anterior (the paracone), and the outer posterior (the metacone)—and at the extreme outer edge three small cusps—the anterior (the parastyle), the median (the mesostyle), and the posterior (the metastyle). The styles and cones are connected by conspicuous ridges—the commissures—running respectively from parastyle to paracone, paracone to mesostyle, mesostyle to metacone, and metacone to metastyle. The result is a conspicuous W-pattern, the variations in form of which are of much systematic importance; this pattern is not obscured by the presence of an inconspicuous inner posterior hypocone. The second molar is usually the largest, the third always the smallest (Plate II., Fig. 1).

The lower molars correspond to the upper in size, but the posterior is relatively larger. There are five cusps—the outer anterior (the protoconid), the inner anterior (the paraconid), the inner median (the metaconid), the outer posterior (the hypoconid), and the inner posterior (the ectoconid). These teeth resemble the outer higher portion of the upper molars reversed with the two segments of the W disconnected. In the third lower molar the posterior segment is usually smaller than the anterior. The most prominent cusps are, in the first two upper molars the metacone, in the third upper the paracone, in the lower molars the protoconid[1] (Plate II., Fig. 1).

The key to the teeth and skulls at the end of this article will probably be found useful.

The **colours** of bats, although not usually bright as compared with those of many other mammals, include as exceptions perhaps the brightest tints of the whole class. Although to a great extent creatures of the night, their external coloration is evidently subject to laws similar to those which govern that of diurnal mammals.

The general tints are due often, as in Leisler's Bat, to the tips of the hairs, from which the bases differ in colour. In other cases, as in the Noctule, the hairs are almost or entirely

[1] For further details see Herluf Winge, "Jordfundne og nulevende Flagermus (*Chiroptera*), fra Lagoa Santa, Minas Geraes, Brasilien," from *E. Museo Lundii*, vol. ii., paper 1, 1893.

unicoloured. As in the mammalia generally, the under is frequently lighter than the upper side, and in some exotic species approaches pure white. The ordinary pelage tints are browns of varying shades, but brilliant yellow, rufous, white, blue-grey, and black sometimes appear in certain foreign species. In a few cases there is a conspicuous "piebald" coloration due to the combination of strongly contrasted shades, as in *Scotophilus ornatus* (Blyth). An African false vampire (*Lavia frons*, of Geoffroy) is said to derive the orange colour of its fur from a powder secreted by a gland.

Bats may follow any local or geographical tendency to develop certain tints which manifests itself amongst other vertebrates, as when in dry arid regions they assume the characteristic "desert" coloration.[1]

Many species, such as the Pipistrelle, are characterised by a wide range of colour variation, amongst which three phases—brown, rufous, and dusky—are conspicuous, but are connected by many intermediate types. The last corresponds to melanism in other mammals, and may be regarded as an almost normal form of variation. Albinism, on the other hand, occurs as an abnormality, probably pathological—which may affect the whole body, including the eyes, wings or ears, or may be restricted to certain definite regions only.

Sexual differences of coloration are said to exist in the Serotine, but I cannot find them in this or any other British bat. In Dobson's experience females are usually darker than males, but in certain South African instances the reverse is said to be the case.[2] The most conspicuous examples occur in India, where the female of *Hipposiderus fulvus* assumes a vivid coloration during the breeding season. In *Scotophilus kuhlii*, a common bat at Calcutta, the underside of the pregnant female changes from pale straw colour or whitish to rich saffron, "exceeding that of the canary bird."[3]

The colour distinctions between young and old, and

[1] *E.g.*, Thomas' *Rhinolophus denti* of Kuruman, South Africa (*Ann. Mag. Nat. Hist.*, May 1904, 386); and his *Vespertilio matschiei* of Aden (*Ann. Mag. Nat. Hist.*, Nov. 1905, 573.

[2] E.g., *Miniopterus dasythrix* of Temminck and *M. fraterculus* of Thomas and Schwann; see *Proc. Zool. Soc.* (London), 20th Feb. 1906, 161-162.

[3] *Proc. Zool. Soc.* (London), 4th March 1873, 241-252.

between adults at different seasons of the year, have been little studied, and nothing is definitely known as to how the fur is moulted. Usually the immature pelage is more uniform, due to absence of grizzled hair tips, but it may be either darker or lighter than that of the adult. In young Natterer's and Whiskered Bats the ventral and dorsal surfaces are more strongly contrasted in coloration, while the first coat of young Horseshoes is recognisable by its grey tint.

Secondary sexual characters, other than those of colour, are commonly found amongst exotic bats, the males of which exhibit many remarkable glandular structures.[1] The measurements given in this work suggest that the wings of females are on the average larger and the animals themselves heavier than the males.

Variations other than those of colour are still in need of attention, and further study may reveal the presence of local distinctions at present unknown. Meanwhile it has been shown that both the British Horseshoes are on the average slightly smaller than those of the neighbouring continent; the same may prove to be true of the Long-eared and, I suspect, also of the Barbastelle. The British Bechstein's Bat also presents some differences, but this bat is so little known that the nature of its variations is obscure.

Abundance and geographical distribution:—Outdoor knowledge, no less than museum study, has advanced haltingly, and all the more so since bats, like cetaceans, are the bane of some writers on geographical distribution, the possession of wings in the one case and of swimming equipment in the other having apparently convinced them that both orders must be exempt from the laws governing the distribution of other mammals. This error, combined with ignorance of distinguishing characters, has in the past led to much confusion of species and incorrect notions as to their relative numbers. Locally abundant bats such as Leisler's, and others so common and widely distributed as the Whiskered, have shared a reputation for rarity with Bechstein's, while Natterer's, Daubenton's, and the Barbastelle have been surrounded with much unnecessary and mysterious obscurity.

[1] See also Osburn, *op. cit. infra*, 77.

The truth is that every undoubtedly British species, except the little-known Bechstein's, and, perhaps, the Barbastelle, is now known to be somewhere common. In some of the southern English counties the numbers occurring in a single locality and even in the same sleeping place, although not usually in the same crevice, are surprising. In the artificial caverns at Henley-on-Thames at least four[1] species congregate, while ten have been taken within the limits of the surrounding demesne. Again, in Normandy MM. Paul Noel and H. Gadeau de Kerville found no less than seven species—the two Horseshoes, Daubenton's, Natterer's, with the Notch-eared, Whiskered, and Mouse-eared—resorting to a single cavern.[2]

Neglect of bats is a grave error in studying geographical distribution, since, inasmuch as these creatures are possessed of the power of surmounting obstacles which to other mammals must be insuperable, their permanent restriction to definite regions must be due to causes of fundamental importance. And, whereas the wings of bats should have enabled them to occupy with uniformity the entire extent of the British Islands, we find in fact that their distribution therein is not less restricted than that of other mammals.

In considering the distribution of bats, it must be remembered that physical features, such as woods, water, and caves, have a very distinct influence on their abundance. Probably no species are less particular about their haunts than the Long-eared and Pipistrelle, and they accordingly may be met with in almost every part of the kingdom, one or the other having found its way to the Shetlands and to remote western Irish islets. Some, especially the Noctule and Leisler's, and perhaps the Whiskered, are probably dependent for their existence on woods, while caves, at least in winter, are no doubt essential for the complete comfort of the two Horseshoes. Daubenton's, on the other hand, restricts itself to the neighbourhood of sheltered streams or stretches of water.

The most striking fact in the distribution of British bats is the progressive westward decrease in species, from Normandy with fifteen, through Great Britain with twelve, to Ireland with

[1] Daubenton's, Natterer's, Bechstein's (once), and Lesser Horseshoe (once).
[2] *Bull. Soc. Amis. Sci. Nat.* (Rouen), 4th April 1901, reprint, 2.

only seven. Skandinavia, on the other hand, has nine and Denmark twelve.[1]

The second fact is the paucity of species in Scotland. Exact details are not in every case available, but only the Pipistrelle and Long-eared are known throughout that country. Daubenton's may fairly be classed with them, as it is attached, often in abundance, to the larger water systems, but for the rest, all that Scottish naturalists can point to are isolated occurrences of the Noctule, Whiskered, and Natterer's, giving a total of three regular and three apparently scarce species. Mr William Taylor's recent record of the Noctule so far north as Elgin probably indicates this bat as a regular member of the Scottish Fauna; and inasmuch as in Skandinavia Natterer's, although rare, is known to occur up to 59° north latitude, the Whiskered to 68°, while Daubenton's is one of the commonest bats, and all three are known from Ireland, it is difficult to avoid the assumption that the range of all three in Scotland is more extensive than published information would lead us to suppose.

A third noticeable fact is, that amongst the seventeen species inhabiting the six countries, Normandy, Denmark, Skandinavia, England, Scotland, and Ireland, no less than seven distinct variations in distribution occur. Only four, *noctula*, *pipistrellus*, *daubentoni*, and *auritus* are regularly met with in all five, but two more, *mystacinus*[2] and *nattereri*,[3] differ only in their apparent absence from Scotland. Two, *leisleri* and *hipposideros*, are absent from Denmark, Skandinavia, and Scotland: one, *barbastellus*, only from Scotland and Ireland. Two are confined to Normandy and a restricted portion of England: of these, *ferrum-equinum* is southern and south-western, while *serotinus* is distinctly south-eastern. Lastly, two, *murinus* and *nilssoni*, are found only in Skandinavia and Denmark, while two more, *myosotis* and *emarginatus*, are known only in Normandy. *Dasycneme* occurs in Normandy and Denmark, but is doubtfully a native of Skandinavia. The partial and individually varying British ranges of the majority of the species is in strong contrast to their wide range

[1] I exclude from the Skandinavian fauna, for the purposes of this article, *Pipistrellus nathusii* and *Myotis dasycneme*; the status of either is doubtful.

[2] With two Scotch records. [3] With one Scotch record.

elsewhere. It is evident that the islands are the meeting-ground for bats having elsewhere different types of distribution. *Bechsteini* and *nathusii* are so little known that they may be excluded from consideration.

Habits:—The general habits of all insectivorous, as compared with frugivorous bats,[1] are at first sight very similar, and it is only of late years that they have attracted much attention from British naturalists, thanks mainly to Messrs Alcock, Coward, C. B. Moffat, Charles Oldham, Tomes, and Arthur Whitaker.[2]

Most species have their peculiar haunts, which they frequent in preference to, but not to the entire exclusion of, all others. The narrow-winged Noctule and Leisler's Bat, the fleetest of their race, often accompany the swifts to great heights in wooded districts. These and other strong fliers swoop falcon-like on their prey when in full flight, but the Long-eared, using its ears like sensitory tentacles, the Whiskered, and probably Natterer's and the Barbastelle, although not incapable of captures in mid-air, more usually snatch resting insects from the branches of trees. Daubenton's, on the contrary, obtains its food hovering over the surface of water, and is often accompanied by others, especially by Natterer's. The Serotine loves glades and gardens, feeding around trees, although not actually amongst the branches. The Pipistrelle, whilst it affects a variety of situations, is pre-eminently the familiar bat of our farmyards and houses. The rare Bechstein's has not been definitely connected with any special habitat, but the butterfly-like sailing on expanded wings of the two Horseshoes is quite characteristic. The latter possess such a wonderful power of threading their way through intricate places in captivity that it seems almost impossible to believe that they do not naturally

[1] This distinction, like others used for purposes of convenience, is not absolute, since some of the bats with insectivorous dentition eat fruit (see Dobson's *Catalogue of Chiroptera*, 390, 466, 503, 511, 514, etc.), suck the blood of larger animals (*op. cit.*, 155, 466, 486, 549), or catch shrimps, fish (*op. cit.*, 397), small birds or mice (A. M. Primrose, also E. Gleadow, *Journ. Bombay Nat. Hist. Soc.*, xvii., 1021-1022).

[2] Some important allusions to habits are scattered through Dobson's *Catalogue of Chiroptera*. P. H. Gosse's *Naturalist in Jamaica*, 1851, contains original observations on the bats of that island. His allusions to the crepuscular habits (p. 162) and segregation of the sexes (p. 294) in some species are probably amongst the earliest published references to these points in their economy. Another paper of great interest, W. Osburn's "Notes on the Cheiroptera of Jamaica," in *Proc. Zool. Soc.* (London), 24th Jan. 1865, 61-85, deals with fruit-eating bats.

hunt amongst branches of trees or it may be in ivy or rocks. The suggestion is supported by Mr Coward's observations on captives of the larger species, which showed a remarkable aptitude for seeking their prey upon the ground, a habit not known in any other British bat, and recalling those of the African Lavias, which also possess a nose-leaf.[1]

All bats love shelter, and are much impeded, or entirely kept at home, by foul weather, even in summer, at which season it is probable that exceptional cold or wet causes the death of many from starvation.[2] The delicate Lesser Horseshoe is probably the most susceptible to wind. The larger kinds, and even the lesser when they have to deal with small insects, devour them on the wing, usually rejecting the wings, elytra, or other indigestible portions, which have been noticed falling thickly from a party of feeding Noctules. As a rule, bats of small size, such as the Pipistrelle, retire from flight for a few moments after the capture of a large insect—a course scorned by such strong flyers as the Noctule or Leisler's Bat. To help them in retaining their grip, it appears almost certain that all the *Vespertilionidæ* make more or less frequent use of the interfemoral membrane as a kind of bag or pouch (Plate VIII., p. 104). Into this the head is dipped and the struggling captive pressed against the membrane until it is overcome. The larger the interfemoral membrane, the easier is its use as a pouch; and, as if ready at a moment's notice, its position in flight is generally with the tip somewhat below the horizontal. The basal portion is, however, kept taut by the widely separated feet with their strong spurs or calcaria.

In Natterer's Bat the interfemoral is weakly developed, is carried horizontally in flight, and is possibly used infrequently as a pouch, but in the Horseshoes alone of British bats this membrane is too small for such a function, and in fact in their case the tip of the tail is normally carried bent over the back (Plates XIX. and XX., pp. 228 and 250). They have, however, an exceptionally developed antebrachial membrane, and when eating their prey they press it against one of the wings, seldom withdrawing their head until the meal is finished. The heaps of refuse which may be found accumulated under their resting

[1] Dobson's *Catalogue of Chiroptera*, 160. [2] Whitaker, *Naturalist*, 1907, 418.

places, supported by direct observations of captive individuals by Mr Coward, show that they usually prefer to alight to feed. The weak interfemoral membrane of the Horseshoes, correlated as it is with great perfection, but not rapidity, of flight and remarkable development of nasal sensory organs, is worthy of more than a passing notice, and is probably, as in the Barbastelle, connected with very special habits: in this connection it should be remembered that the whole sub-order of fruit-eating bats are unprovided with an interfemoral membrane.

In the whole order the powers of flight[1] are distinctly superior to those of birds, especially, as Mr Hahn observes, in the power of checking momentum. Their remarkable agility when hunting, and the hours at which they appear, make bats, as a rule, safe from the attacks of predatory creatures. But instances are on record of their pursuit or capture by a stoat,[2] or by hawks[3] or owls.[4] On one occasion a small bat and a large beetle were observed to fall to the ground together, having probably come into collision accidentally;[5] while Mr Lionel E. Adams writes me that he once saw a bat fly into a bicycle. The position of the wings when in action differs, as Osburn[6] pointed out, from that of birds, the arc formed by the tip scarcely rising above the plane of the body, beneath which the wings seem to meet in their downward stroke.

The observation of their habits is somewhat complicated by the fact that sometimes members of a colony may remain inactive all night. Subject to such exceptions, however, it is now definitely known that most bats, such as the Pipistrelle, Daubenton's, and Long-eared, normally continue their flight, no doubt with intervals for rest, throughout the night. Others, represented in Britain by the Noctule and Leisler's, take their flying exercise twice a day, contriving to secure all the food that they need in the course of two headlong careers of from eighty to one hundred and twenty minutes each,

[1] On this subject, see Baron Francis Nopcsa's "Ideas on the Origin of Flight," *Proc. Zool. Soc.* (London), 19th Feb. 1907, 223-236.

[2] George Wolley, *Zoologist*, 1846, 1204.

[3] G. J. Talbot, *Field*, 10th Oct. 1903, 635; F. J. Montgomery, *Field*, 26th Sept. 1903, 532. An African hawk is said to feed on bats—see C. J. Andersson's *Birds of Damara Land*, London, 1872, 23, and for the hobby, John Sclater, *Zoologist*, 1875, 4538: in British Columbia the large rainbow trout leaps at and probably catches them—John Macoun, quoted by E. Thompson Seton, ii., 1181.

[4] *Zoologist*, 1887, 426-427. [5] J. H. Wilmore, *Zoologist*, 1886, 242. [6] *Op. cit.*

just after sunset and before sunrise. Except when hindered by stormy weather, their appearances are very regular. Amongst the earliest to fly are the inappropriately named Serotine and the Barbastelle, which with the Noctule and Leisler's, may all be seen accompanying swallows and swifts on the wing. The Pipistrelle has been shown to appear in Ireland soon after sunset, and Daubenton's Bat, although seldom noticed, is probably also an early flier. Details regarding the others are wanting. Thus, although nominally creatures of the night, bats normally appear abroad long before the onset of darkness, and do not return home until daylight is far advanced. The times of emergence and retirement are so adjusted to suit the seasons that, as the autumn evenings darken, they awake at a progressively earlier hour, and in the winter, should they fly at all, they often do so in daylight. Apart from this, midday flights, although probably due in some instances to disturbance,[1] are so frequent that they can hardly be regarded as extraordinary.[2] It seems likely, therefore, that bats can have no inherent objection to light, and many exotic species[3] are regularly active in the daytime, especially those inhabiting shady woods. Again, British bats are often found asleep in summer in positions where they are exposed to moderate or even bright light.

The **diurnal retreats** are no less varied than the nightly hunting grounds. But here, again, no fixed rule can be rigidly applied. Most species, besides using the shelter of trees when on the wing, find a safe refuge in their trunks. Houses, too, are resorted to where there are convenient cavities; and caves, although often so damp that the fur of the bats hibernating in them is wet, are very much appreciated in winter, probably on account of their equable temperature.[4] Indeed, the occurrence of Horseshoe Bats in any district appears to depend in some degree on the presence of caves, in which many other kinds also con-

[1] See H. W. Newman, *Zoologist*, 1859, 6317.

[2] A remarkable instance is related by A. J. Dasent, *Field*, 7th Sept. 1889, 350.

[3] *E.g.*, amongst others, *Nyctalus azoreum* of the Azorean oak woods; *Rhynchonycteris naso* of Amazonia and Guiana (E. A. Goeldi, *Ibis*, 1904, 518); *Lavia frons* of Tropical Africa (P. L. Sclater and J. H. Speke, *Proc. Zool. Soc.* (London), 8th March 1864, 99).

[4] Hahn found that for a period of two years' observations the extreme variation of temperature in a bat-cave was from about 51° F. in January to 57° F. in September (*op. cit.*, 140).

gregate, each as a rule keeping to its own area. As stated above, seven species have been found thus harbouring in Normandy, and it seems likely that the majority of our British bats resort at times to caves. On the other hand, there is, so far as I am aware, no record of the occurrence in British caves at any time of the Noctule, Leisler's Bat, or Serotine, while it appears that the Pipistrelle enters them very rarely. When at rest bats either hang suspended, head downwards, their feet gripping tightly the inequalities of wall or ceiling, or they may lie along a slope, or may wedge themselves into cracks or crevices. One exotic species, the Flat-headed Bat,[1] has the head peculiarly flattened, as if to enable it to creep into narrow places. In repose the wings of vespertilionid bats are folded close to the sides, but almost completely envelop the body in the Horseshoes. Bats are extremely conservative in their affection for particular haunts. In Kent's Hole, Devonshire, where Montagu caught his Horseshoes, the heap of excrement[2] and bones associated with those of long extinct animals seem to suggest an immemorial tenancy. Certain situations are again much favoured, and when a captive bat is introduced into a room it shows a tendency to suspend itself time after time in one spot. In spite of this, disturbance by man may cause a temporary or permanent desertion of a favoured retreat, and even Kent's Hole is now little frequented.

The manner of alighting is interesting. The usual method is to secure a hold with the thumbs, and then shuffle quickly round into the ordinary position with head downwards. The Horseshoes are, however, so agile that, turning a somersault in the air, they contrive to get an immediate grip with their feet. This manœuvre is combined with exceptional power of obtaining hold, so that these bats can easily suspend themselves from such smooth surfaces as a curtain pole, which are quite impracticable for a Noctule. Only two other species, Natterer's and the Barbastelle, have been observed to follow

[1] *Platymops macmilani* of Thomas, *Ann. and Mag. Nat. Hist.*, May 1906, 499-501.

[2] Osburn, writing of fruit-eating bats in Jamaica (*Zoologist*, 1859, 6588-89), mentions deposits "of great extent and many feet in thickness, on the floors of the caves," which in one case could not be less than half a mile in length. See also H. L. Ward's remarkable account of a Mexican bat-cave in *Trans. Wisconsin Acad. of Sci., Acts and Letters*, xiv., 11, 634, etc., 1903 (1904).

the Horseshoes' method of alighting, and they only do so occasionally and with but partial success. It is noticeable that all three have weak thumbs.

Practically all bats are gregarious: even the Whiskered and Barbastelle, so long supposed to be solitary, have been found in colonies. In the case of the Noctule, Leisler's Bat, and the Serotine, these colonies are not known to include individuals of other species. The two Horseshoes are moderately exclusive, but are often encountered in each other's company in regions where both occur, and in France the smaller kind is on good terms with the Notch-eared Bat. Most other small bats do not object to the presence of an alien, but as a rule each species, and indeed each individual,[1] is segregated, and in hibernation the most sociable, as the Long-eared and Leisler's, are often solitary.

In spite, however, of the sociability of the majority, individuals may often be found living by themselves and frequently changing their lodgings with the whim of the evening. It is certain that, apart from sex, the causes leading to the congregation or the segregation of bats are still obscure and in need of investigation.

Besides thus changing their domicile, many bats alter their feeding grounds with the season, since they must perforce attend the migrations of their prey. Rivers and pools, lanes and hedges, ivy-covered walls and ruins are all sought at the times when they most attract insects, a knowledge of the habits and flights of which is essential to a bat-hunter.[2] During the cockchafer flights the Kentish Serotines catch these beetles as they buzz at low elevations around trees and bushes, but later in the summer not one will be seen where before they have been numerous. So the Noctule and Leisler's Bat vary their hunting-grounds, and may travel considerable distances from home;[3] although, where food is always abundant, their appearance and movements are almost as regular as clockwork. Again, Daubenton's Bat probably takes a flight in mid-air before

[1] In the Mexico bat-cavern each species was disposed "in a band of some feet or yards in width; then a slight vacant space, followed by a band of another species." —Ward, *op. cit.*, 635.

[2] F. Norton, *Midland Naturalist*, 149, 1883.

[3] C. Nicolle and C. Comte state that of forty-seven examples of *Pipistrellus kuhlii*, marked and liberated at a distance of two kilometres from their retreat, six were eventually recaptured where originally taken.—*Compt. rend. Soc. Biol.*, Paris, lx., 738-739, 1906.

settling down to the water surface. Others alter their beats but little throughout the year, but none is more regular than the Pipistrelle—which may be encountered night after night on the same restricted course.

On the whole the food appears to consist of such insects as may happen to be caught; the choice depending, perhaps, rather on the strata of the air in which insects are flying than on any preference for particular kinds. The high flight of the Noctule and its size seem to bring it largely into contact with the large strong-flying beetles which the Greater Horseshoe seems to catch before they have risen to high altitudes. The smaller bats probably rely on flies and small moths for the chief part of their sustenance. The resort of the Water Bat leads it to capture caddis-flies, but for the remaining species there is no observed differentiation. In captivity practically all insects are accepted except those which are distasteful to insectivorous animals generally. Messrs E. L. Rollinat and R. Trouessart[1] find that whereas the Mouse-eared, Natterer's, and Daubenton's Bats devour cockroaches with avidity, the Serotine, Pipistrelle, Long-eared, Barbastelle, and Notch-eared show no marked predilection for them. Bats in general are extremely voracious, and their powers of consuming insects will be alluded to in connection with their habits in confinement.

Bats are thirsty creatures and love to lick up water or milk. In nature they often drink, like swallows,[2] on the wing, and, although there is no reason to suppose that, like the birds, they seek to wash themselves in the water, they have been occasionally detected alighting on its surface,[3] and on such occasions have surprised the observer by the agility with which they rowed themselves along with flapping wings, or at will resumed their flight. A Long-ear has been observed settling by some water to drink.

As is well known, bats afford a conspicuous instance of the phenomenon of **hibernation,** on which subject the brilliant researches of the Italian Lazarre Spallanzani,[4] although undertaken over one hundred years ago, are still fascinating reading.

[1] *Op. cit. infra*, p. 32. [2] As noticed by Gilbert White.
[3] J. G. Millais; C. M. Smith, *Field*, 20th July 1889, 97; Lord Lilford, *Zoologist*, 1887, 66 (*M. mystacinus*). [4] *Op. cit. infra*, p. 30.



NOCTULE BATS. (About $\frac{1}{3}$ natural size.)

All British species are liable to enter the lethargic condition should the temperature fall low enough, but they may rapidly awake in response to heat, as when warmed in the hand, so that their lethargy is never very profound. At such times the body-temperature rises rapidly, sometimes as much as 31° Fahrenheit in fifteen minutes, the muscles shudder, the animal pants and throbs, becomes lively, squeaks, and is fully awake. Before commencing hibernation, bats are, as a rule, very fat, their weight being appreciably greater than in early summer, at which time some species are thin. Mr Hahn believes that the degree of lethargy bears a close relation to the supply of superficial fat, and is not connected with temperature or season. The American bats examined by him became more active as the winter advanced, but this is contrary to British observations. At all times, as in Britain, there was much irregularity of movement amongst individual bats.

The more general belief is, however, that the duration and depth of the hibernatory sleep depend largely, although not entirely, on temperature, and consequently on locality and season. In warm climates bats, like hedgehogs, probably do not hibernate at all, while in the temperate regions, such as Britain, the process is by no means constant, but varies with the species, for each of which there is no doubt a definite temperature inducing torpidity. Individuals, however, may constantly be found abroad at exceptional temperatures, but the body never becomes so physiologically awake as to ovulate.

Leisler's Bat is probably one of the earliest to discontinue flying, and in Ireland, although it has been observed so late as the 16th November, the majority as a rule disappear about the end of September. Its congener, the Noctule, has been observed abroad in every month except January, but its winter appearances are the exceptions that prove the rule. The Long-eared is more hardy and is frequently caught in winter: it probably shifts its quarters at intervals throughout the winter. The Barbastelle has been taken on New Year's Day. A Daubenton's Bat has been found on the wing at a temperature of 42° Fahrenheit, and another contained recently digested food in December. Natterer's leaves its winter quarters in February, while the Horseshoes, the Whiskered, and the

Pipistrelle probably fly whenever the weather is mild throughout the winter. An evening temperature of 40° to 43° Fahrenheit is probably required to keep the latter at home, the corresponding figure for the Long-eared being one or two degrees higher. On the other hand, it is probably the temperature of midday that influences Leisler's Bat in its winter flights. Most authorities are agreed that bats fly more frequently in the early than in the later months of winter, by which time probably most insect life has been killed by frost. In the equable temperature of churches and caverns they are active although they may not venture outside, and the delicate Horseshoes probably snatch irregular meals on the cave-haunting moths and spiders which share their winter quarters.

North American naturalists have proved that bats perform regular **migrations**, but it is not clear that they do so to avoid hibernation. Of six species found in Manitoba, according to Mr Ernest Thompson Seton,[1] "all are migratory and yet hibernate," and the seasonal journeys of at least three of them, the Red, the Hoary, and the Silver-haired, are on a scale comparable with those of birds. The second of these has even been known to cross from the American continent to the Bermudas, a distance of over six hundred miles. The regular passage of these bats over the Atlantic was invested with special interest in view of an old record of the occurrence of one of them in the Orkneys. Unfortunately this turns out to be an example of a Hawaiian species,[2] which cannot possibly have reached this side of the Atlantic unassisted.

Occasionally bats are reported from lighthouses as if they were migrating,[3] but it is regrettable that for Europe there is on this point not much definite information, although it is more than a century since Spallanzani wrote that in Italy most bats are migrants.[4] More recently Bell accepted Blasius' belief in the migration of the Northern Bat,[5] based on

[1] *Life Histories of Northern Animals*, ii., 1909, 1161.

[2] *Nycteris* (=*Lasiurus*) *semota*.

[3] R. M. Barrington, *The Migration of Birds*, 284: R. H. Porter, London, 1900, gives records from Fastnet, Rockabill, Blackrock (Mayo) and Tearaght, on the west, and from Lucifer Shoals and Arklow South on the east coast of Ireland.

[4] *Rapports de l'air avec les êtres organisés*, ii., 179, édition Jean Senebier, Geneva, 1807.

[5] *Vespertilio nilssoni*.

the fact that no one had ever been able to find hibernating individuals of this species in extreme northern countries. Although this bat is believed to breed only in regions lying approximately between 54° and 58° north latitude, it is observed with its young, after the breeding season is over, as far north as 68° or 70°. Blasius, therefore, assumed a change of habitat of at least ten degrees of latitude. It wanders north, however, only at an advanced season of the year, so that, since rough weather sets in at the beginning of October, Blasius supposed that the bats could not remain for more than six weeks before returning to their winter quarters in the south. Corroboration of these facts is highly desirable, especially since the supposed summer migration of the Eastern Pipistrelle[1] to central Europe and Sweden turns out to rest on an error of identification, this bat having been confused with another non-migratory species.[2]

Similar instances, although in different countries, are on record. The Euryale Horseshoe[3] is plentiful in summer in central France, but Messrs Rollinat and Trouessart in the course of many years' bat-hunting have never once detected it between the months of October and June. If it does not migrate south to pass the winter, it must retire to the depths of caverns which are inaccessible to man—a somewhat unlikely alternative when it is remembered how intermittent is the winter sleep of bats. Farther south Macpherson[4] believed that in April 1891 he saw a small flock of large bats migrating through one of the passes of the Pyrenees, at which point the available evidence ends. Mention must, however, be made of Mr A. H. Howell's suggestion that when migrating bats fly high and by day.[5]

The **breeding habits** of bats have been but little studied by British naturalists, who have recorded merely isolated observations, from which it would be impossible to piece together a connected history. Continental zoologists[6] have,

[1] *Pipistrellus abramus.* [2] *P. nathusii.* [3] *Rhinolophus euryale.*

[4] *Lakeland*, 1892, 1. [5] *Infra*, p. 223.

[6] B. Benecke, *Zoologischer Anzeiger*, ii., 1879, 304-305 (*pipistrellus* and *auritus*): Eimer, *op. cit.*, 425-426 (*noctula* and *pipistrellus*): E. van Beneden and C. Julin, *Archives de Biologie*, i., 1880, 551-571, pls. xxii. and xxiii. (*daubentoni*, *dasycneme*, *myosotis*, *mystacinus*, *nattereri*, *emarginatus*): O. Van Stricht, *Anatomischer Anzeiger*, xix., Suppl., 1901, 208-210 (*noctula*, *pipistrellus*, *myosotis*): Fries, Ueber die Fortpflanzung der enheimischen Chiropteren, Nachrichten, *K. Gesellsch. der Wissensch, Univ. Gottingen*, 1879, 295-298, (*noctula*, *pipistrellus*, *nathusii*, *abramus*, *serotinus*.

fortunately, paid more attention to the subject and have proved conclusively that in their country the normal breeding season is autumn. At that season spermatozoa are found numerously in the uterus of the adult female, and the organs of the male are also functional. Ovulation is, however, postponed until the termination of hibernation, during which period the ovaries are quiescent, but the spermatozoa retain their activity in the uterus until fertilisation takes place in April. On this point all authorities are agreed, and the facts, subject to correction as to details, may be taken as substantiated. An alternative view, that ovulation and fertilisation may take place in the autumn and winter, with subsequent postponement of the development of the embryo, seems to be unsupported by facts.

A point still open to discussion is the occurrence of copulation in spring. Messrs Rollinat and Trouessart, whose observations, as briefly summarised below, are the most complete in existence, altogether deny that it takes place even in the case of a female which has missed autumnal impregnation. They admit, however, the evident ability of the male, and the fact remains that acts of courtship have been reported in spring, as in Wales by Mr T. W. Proger, for the Lesser Horseshoe; his observations, however, are not definite as to consummation. Again, in France, Monsieur M. Duval[1] has noticed such acts amongst captive bats, but it is possible that they may have been abortive, and observations on captive animals are rarely of value on such points. The matter deserves further study, but since the breeding season may vary with locality and climate, conflicting reports from observers in different countries are naturally to be expected.

The work of Messrs Rollinat and Trouessart[2] is based partly upon a study of a non-British bat, the Mouse-eared,[3] and

myosotis, *mystacinus*, *nattereri*, *bechsteini*, *auritus*, *barbastellus*, *hipposideros*): Carl Vogt, Association française pour l'avancement des Sciences, sess. 10, Alger, 1881, *Compte rendu*, 655-662: thus including all British species except *leisleri*.

[1] *Études sur l'Embryologie des Chiroptères*, I, Paris, 1879. For a description of copulation, which takes place while the animals are at rest, not in flight, see Hahn, *op. cit.*, 161; Victor Fatio, "Vertébrés de la Suisse," i., 23, 1869; Duval, "Sur l'accouplement des Chauves-Souris," in *Comptes rendus Soc. Biol.*, Paris, 23rd Feb. 1895, 135-136.

[2] "Sur la reproduction des Chauves-Souris," *Mem. Soc. Zool. de France*, ix., 214-240, 1896.

[3] *Myotis myosotis*.

partly upon the Horseshoes. It is both the most recent and one of the most complete essays on the subject, and may therefore be summarised somewhat fully. More exact details will, where known, be found under the heading of each particular species. Meantime, British naturalists have a model life-history with which they can compare their own observations.

The authors found both sexes of the Mouse-ear living in company in September. The genital organs of the male are then highly developed, but the female organs are small and not remarkable, except that the uterus contains numerous spermatozoa. At this time the female is very fat, and remains so till after parturition, whereas the male is very thin. No change was observed in the bats throughout the winter. Towards the middle or end of March hibernation ends and the active life of summer is resumed. Ovulation ensues, and, the ovum having been fertilised, the superfluous spermatozoa are expelled, and gestation commences—almost invariably in the right horn of the uterus.[1] A few days usually intervene between resumption of activity and fertilisation, so that gestation commences most frequently in the first week of April. After fecundation the females form separate parties, to which no male is admitted, but in which non-breeding females are present. These "nursing colonies," as they may be called, do not break up until the young have been reared, after which they disperse to their winter quarters.

The date of birth of the young varies a good deal. Thus a female, captured while still hibernating on the 7th March and kept warm, became a mother on the night of the 4th May (fifty-eight days), whereas others taken at later dates brought forth their young between 28th May and 9th June (a minimum of fifty-eight days if they emerged from hibernation on 1st April). Apparently, then, the commencement of gestation may be hastened by warmth. Allowing a few days between the termination of hibernation and ovulation, it would appear to last at least forty-nine days, or seven weeks. In many cases its commencement is delayed, and females captured on 3rd and 17th April had not yet ovulated, although containing spermatozoa.

[1] Duval, "Études sur l'Embryologie des Cheiroptères," in *Journ. de l'anat. et de la Physiol.*, xxxi., 93-160, March to April 1895; but the authors once found a Serotine with an embryo in the left horn.

The authors think that these must have spent the winter in some cold or windy situation, thus rendering spring revival sluggish. At all events, the female gatherings increase in size all April.

By 5th June many wild young had made their appearance, and their growth was very rapid.

The authors ascertained that the female does not pair until her second autumn, when about seventeen months old. Sometimes even, although to all appearance sexually mature, she remains virgin throughout the following summer, apparently until her third autumn. There are thus in the autumn assemblages three types of female. That of the first year, being virgin, may be distinguished by the small and undeveloped mammary and generative organs, the latter never containing spermatozoa, and by the usual external indications of immaturity especially in colour, teeth, and wings. That of the second year, now breeding for the first time, is more developed, but the uterus is always smaller than in the adult which has borne young. The latter has the mammæ plainly visible, and the right horn of the uterus distinctly larger than the left.

When the bats leave their winter quarters, the virgin female of the first year accompanies the adult of the same sex, but leaves soon after the birth of the young. That of the second year, on the other hand, even when herself virgin, never leaves the company of the breeding females. The existence of the class of virgin females, both of the first and of the second years, throughout the spring, although it led Carl Vogt[1] to suppose the necessity for spring copulation, convinced the authors that no such act takes place at this season.

That there should be no spring copulation is difficult to understand, since the adult male is in train to breed from September until April. The state of the organs indicates a season of rut, and the authors express astonishment that, in spite of this, they are so long inactive. They suggest that reabsorption of the spermatozoa may take place in accordance with the Brown-Sèquard theory of internal secretion. Although the authors express no doubt as to the absence of spring copulation, the conclusion, in view of the condition of the male, is so surprising as to seem in need of corroboration.

[1] *Op. cit. supra*, p. 32.

As with the female, so with the male, there are three classes, comprising that of the first autumn, which does not breed, that of the second autumn, which probably breeds but rarely, and that of the third and subsequent autumns, which is fully adult.

Parturition was observed in a single case. The mother had previously arranged herself with her head uppermost, and the young one was born feet first and received in a cradle formed by the maternal interfemoral membrane. The mother severed the cord with her teeth. The whole process occupied a period of slightly over half an hour. Thirty minutes later the mother resumed her usual position with the head downwards, and the young one occupied a position under her left wing with the left nipple in its mouth. There it remained for eleven days, after which it passed its time partly hanging by itself, partly under the maternal wing.

The young Mouse-ear at birth, despite the fact that the wings are of late development in the embryo,[1] has an expanse of 130 to 160 mm. It is almost naked, its colour blackish or brownish above, but unpigmented beneath, the wings slightly pigmented. The eyes are closed, the ears more or less reflexed. The limbs are well developed, especially the claws, both of the thumbs and feet, which are sharp and curved. The hooked and trilobed teeth of the milk dentition arm the front of the jaws.

It is with the claws that a young bat clings to its mother's fur, holding on also by its teeth to the nipples, of which there are a pair, specially long corrugated structures, placed pectorally.[2] So firm is the grip that a very young bat taken in the hand will attach itself so firmly to the fingers as to be separated only by vigorous shaking. The mothers have at first no difficulty in carrying their young, which cling to them with the hind feet buried in the fur of the abdomen, the thumbs clutching the breast and neck, a nipple firmly fixed in the mouth. Sometimes during flight the young one bends downwards so that

[1] For an account of some embryos of bats, see Harrison Allen's paper in *Contributions from the Zoological Laboratory of the University of Pennsylvania*, vol. i., No. 2, 1895.

[2] Dobson (*Catalogue of Chiroptera*, 79 and 83) observed that in the males of some fruit-eating bats the nipples are as large as in any female during lactation, and suggested that, where two young are born at the same time, the male may relieve the female of the charge of one.

daylight may be seen between its body and that of its mother.

The young grow rapidly, soon acquire hair, and are always strong and vigorous. Their eyes open between the fourth and ninth day,[1] most usually on the fifth or sixth. Between the ninth and thirteenth days they begin to leave their mothers and divide their time between hanging by themselves and attachment to the nipple under the cover of the maternal wing. Probably after the second week the wild female leaves her young one at home when she flies abroad to feed, but takes it under her wing on returning. In fact, Mr Whitaker found that a young Pipistrelle soon became a burden which was carried in flight only with difficulty, and seriously impeded the feeding of its mother on a flat surface, especially when she attempted to "pouch" her food.

On the twelfth day a young Mouse-ear had attained an expanse of nearly 250 mm., and was well covered with hair. The permanent teeth were already replacing those of the milk dentition. A few days later it no longer sought its mother's wing, even when being suckled, but stretched itself frequently and expanded its wings.

By the thirtieth to thirty-fifth day the milk dentition had disappeared, but the young one was not finally weaned until it was about two months old. In the wild parties the young were nearly as big as their dams in July, and the nursing colonies broke up before the end of August. Other species probably vary in these respects, since wild Notched-ears[2] were found to have finished lactation on 26th August, whereas young Euryale Horseshoes, nearly equalling the adults in size, but with stomachs full of milk, were on the wing only on the 18th of the same month.

Some naturalists have stated their belief that the females suckle the young promiscuously,[3] but, except in the case of the Lesser Horseshoe, Messrs Rollinat and Trouessart, after many years of research and experiment, find no evidence of this. Mr Whitaker's report on two Pipistrelles is similar.

The above observations may probably be regarded as

[1] Whitaker gives the eighth day for the Pipistrelle and twelfth for the Noctule.
[2] *Myotis emarginatus.*
[3] *E.g.*, Osburn, in the case of a captive *Monophyllus*, *op. cit.*, 84.



SQUIRREL. (About ½ natural size.)

typical for British vespertilionid bats. The Horseshoes differ from them in certain important respects, and these have been noted under each species. The period of gestation is longer, extending to ten or twelve weeks; the young at birth have the upper surface covered with down; and they hold on to their dams by means of a special pair of false nipples situated in the inguinal region.

Differences of habit will also no doubt be met with in other vespertilionid species. For instance, the number of young at a birth is always restricted to one in the Mouse-ear, as it appears to be also in every British species of this genus, as well as in the Serotine and the Long-eared.[1] The members of the genera *Nyctalus* and *Pipistrellus*, however, present a curious problem, since, although the occurrence of two young at a birth is almost unknown in Britain, continental naturalists frequently credit them with that number, although not at every birth. On this point they are quite definite, and there is nothing inherently improbable in the statement, since in many exotic bats' twins or more are usual, and these are sometimes carried about by the mother even when they have reached about two-thirds of her size.[2] Confirmation in the case of the genus *Pipistrellus* comes from America, where Mr Vernon Bailey[3] finds that the Little Canyon Bat[4] may have either one or two embryos. The facts being as above stated—and, although further investigation is desirable, there can, I think, be no reason to doubt them—we have here a very interesting case of variation in fertility according to locality. My friend Mr Moffat points out[5] that the lower degree of fertility occurs on the outer limits of the ranges of these bats. He compares it with somewhat similar facts in British and Irish birds, which

[1] For *Barbastella* alone I have no information.

[2] See W. H. Hudson for *Molossus bonariensis* in *The Naturalist in La Plata*, 101-104: Chapman and Hall, Limited, London, 1892 The Red Bat of N. America has four mammæ, and one weighing 11 grammes has been taken alive nursing four young, weighing collectively 12·7 grammes (M. W. Lyon, jun., *Proc. U.S. Nat. Mus.*, xxvi., 425-426, 1903).

[3] *North American Fauna*, No. xxv., 210, 1905.

[4] *P. hesperus* (H. Allen); *P. abramus* of Java has also been found with two embryos (see G. M. Allen, *Bull. Mus. Comparative Zool.*, Harvard College, lii., 3, July 1908, 45); and *P. subflavus* of N. America with three (Hahn, *op. cit.*, 162).

[5] "The Problems of an Island Fauna," *Irish Naturalist*, 1907, 141.

are said to lay fewer eggs than on the continent, and in Ireland than in England. Certain butterflies, also, produce a single brood in Ireland as against two in England, while in others the number of males is excessive.[1] All the facts lead him to suggest that diminished fertility occurs as an exterminating factor at the outskirts of an animal's range.

As regards other details, there is evidence that seasonal change of domicile and the formation of nursing colonies obtains in every British species of which we possess records in any detail. Especially is this the case with the crowded cave parties which only gather in the gloom of subterranean retreats when the chilly blasts of winter drive them from the slighter shelters of summer.[2] In spring the caves are deserted and their occupants betake themselves to holes in buildings and trees. Our knowledge is most complete in the case of the Noctule, which in spring forsakes the sheltering house-roof wherein it has lain dormant throughout the winter, and forms, usually in hollow trees, nursing colonies, which keep together until the autumn. Mr Symington Grieve's description of the Water Bat at Loch Dochart suggests similar habits. In the case of the Noctule, segregation of the sexes is a general but not invariable rule. The Lesser Horseshoes are as regular, but the females of this species tolerate the males and frequently allow them, both young and old, to associate with them. Less clearly understood, and evidently more complicated, are the summer "swarms" of Long-ears which for a few weeks—sometimes only days—of July or August, cluster in outhouses, where they are unknown throughout the rest of the year. These gatherings, as well as those of the Pipistrelle, include bats of all ages and both sexes.

The date of birth is subject to much variation: of nine instances covering three species given by Mr Whitaker, the earliest birth took place on 22nd June and the latest would probably have occurred in August. Again, in south Wales Mr Proger finds that the young of the Lesser Horseshoe and of

[1] If, as has been suggested, there is a preponderance of males in British Lesser Horseshoes, and that in Germany, as stated by Kuhl, there may be two young, a thing unknown in France or Britain, that would be another case to the point.

[2] For Wales, see Proger, *Proc. Cardiff Nat. Soc.*, March 1905, reprint, 4.

Natterer's Bat are not born until about the last week of June. On the other hand, Mr Coward had a young Water Bat with a forearm of only 20 mm., and a total expanse of only 110 as against 220 in the adult, taken on the wing on 28th June, and on the same day a female which appeared to have recently given birth, while I have examined a young Pipistrelle and Whiskered, fully grown but immature, on 9th August and 26th July respectively.

As stated above, the breeding habits of the various species probably vary with the degree of torpor which they undergo during hibernation and the climate of the locality in which they exist. The most simple are those of bats like Leisler's, which hardly fly at all during the winter. Others which, like the Pipistrelle, fly at intervals throughout the year, probably have a lengthened breeding season and may copulate frequently. But even if they do, Messrs Rollinat and Trouessart find that there is no fecundation until the spring.

The facts as observed in Britain seem difficult to reconcile, unless either copulation takes place in spring, or the commencement of gestation is retarded by a damp climate, just as it is hastened by warmth.

The birth of bats in captivity has been independently observed in England by Daniell and Mr Whitaker for the Noctule, and by the latter naturalist for the Pipistrelle. These observers were only able to approximate the period of gestation at not less than thirty-eight days for the former and about forty-nine days for the latter species, so that as far as they go they do not disagree with Messrs Rollinat and Trouessart. They find, however, that the young may be born head first. In one case the mother hung in the normal position head downwards [1]; in the other this position was reversed.

Many naturalists, from Spallanzani downwards, have referred to a supposed preponderance in numbers of the female sex. On this point no satisfactory evidence is forthcoming, but the apparently superfluous size and capacity of the male generative organs would be accounted for if it could be shown that bats are polygamous.

[1] Sir H. A. Blake (*Sci. Proc. Roy. Dublin Soc.*, IV., N.S., 449-450, 1885) observed the birth of an Indian fruit-bat, in this case also feet first. Professor Robert Collett writes me that he has observed parturition once each in Daubenton's and Nilsson's Bats. The mother in each case hung head downwards.

It is perhaps difficult to account for the **prejudices** which have always existed against these harmless and interesting little animals, which are not only objects of superstitious dread to the ignorant, but have proved to the poet and the painter a fertile source of images of gloom and terror. That the ancient Greek and Roman poets, furnished with exaggerated accounts of the animals infesting the remote regions with which their commerce or their conquests had made them acquainted, should have caught eagerly at those marvellous stories and descriptions, and rendered them subservient to their fabulous but highly imaginative mythology, is not wonderful. It is, indeed, more than probable that some of the Indian species of bats, with their predatory habits, their multitudinous numbers, their obscure and mysterious retreats, and the strange combination of the character of beast and bird which they were believed to possess, gave to Virgil the idea, which he has so poetically worked out, of the harpies which fell upon the hastily-spread tables of his hero and his companions, and polluted, whilst they devoured, the feast from which they had driven the affrighted guests. But that the little harmless bats of our own climate, whose habits are at once so innocent and so amusing, and whose time of appearance and activity is that when everything around would lead the mind to tranquillity and peace, should be forced into scenes of mystery and horror, as an almost essential feature in the picture, is an anomaly which cannot be so easily explained.

They have, however, been connected with various evil deeds as foreign to their natures as sky from earth, with blood-sucking,[1] with maliciously entangling themselves in women's hair, with thefts of meat and bacon, and with mysterious entombments in impossible places.[2] The "wool of bat" was included by the witches of "Macbeth" amongst the ingredients used in preparing a charm,[3] and Tennyson's "black bat night" was surely not used in a complimentary sense.

Sense organs:—No one who sees a bat on the wing in pursuit of its ordinary vocation can doubt that these animals

[1] Article on Horseshoes, *infra.*

[2] *Zoologist*, 1897, 46; T. P. Bartlett, *Journ. cit.*, 1844, 613; A. C. Smith, *Journ. cit.*, 1854, 4245.

[3] Act iv., sc. 1.

possess a marvellous faculty for finding their way about under conditions which would render human beings helpless. A good illustration of this power is described by Professor C. Lloyd Morgan,[1] quoting Miss Caroline Bolton, who was present during an experiment in which threads were fastened crossing each other in all directions at intervals of about sixteen inches in a room measuring twenty feet by sixteen. To each thread a bell was attached in such a way that the slightest touch would make it ring. Into this room a large bat was liberated in absolute darkness, but, although the observers could hear the animal flying about for half an hour no bell was rung.

So keen are their perceptions that, unlike birds, bats usually perceive windows,[2] and if they fly against them, it is not with the blind dash of a bird. It has been noticed of a Lesser Horseshoe that it persistently flew at a large mirror, "and though it never actually touched it, it hovered in front of it in such a way as to indicate clearly that it was in some way deceived by it."

All authorities are agreed that bats are in no apparent way incommoded by the partial destruction of their eyes; but, as regards the loss of power consequent upon the loss of other organs, the older writers differed somewhat, and it seems quite possible that the mere shock or pain caused by the operations of the experimenters may have in some cases interfered with the victim's movements. The element of disagreement is partially lessened and explained by more recent investigators,[3] who, after an examination of several species, conclude that the power which enables bats to move with certainty in the most complete obscurity, is not absolutely located in any single organ, but arises from a combination of senses resulting from several organs acting in unison and mutually assisting each other. The most important of these, in the order named, are: (1) hearing, or rather, as Mr Hahn puts it, a sense or senses located in the internal ear; (2) touch, specially distributed in the naked

[1] *Animal Life and Intelligence*, 1890-91, 247.

[2] Not always—see G. H. Caton Haigh on Daubenton's Bat, *Zoologist*, 1889, 434; also Osburn; and Hahn, whose experiments led him to regard the ordinary estimates of a bat's skill in avoiding obstacles as exaggerated (*op. cit.*, *supra*, *vide* p. 3).

[3] Messrs Rollinat and Trouessart, *Comptes rendus Soc. Biol.*, Paris, 23rd June 1904, 1-4 (reprint).

parts and membranes; (3) sight; (4) smell;[1] and (5) taste. This explanation is so apparently reasonable and in accordance with probability, that it is to be hoped that these unfortunate creatures will escape the pain of further investigations.

Without resorting to the cruel artifices of continental[2] zoologists, an English naturalist, Mr Whitaker, has been able to corroborate their work, and it may now be regarded as almost certain that a vast expansion of the most exquisite sense of touch over the whole surface of the wing, plays a most important part in making nocturnal flight possible. In addition, therefore, to their more obvious uses, the flying membranes,[3] and, it should be added, the ear, with the hairs which scantily cover these parts, almost certainly function as organs of perception. It seems that Cuvier was not far wrong when he wrote that "it is by means of the pulsations of the wings on the air that the propinquity of solid bodies is perceived, by the manner in which air reacts upon their surface." Whether or no the numerous striations which traverse the wings and the interfemoral membrane have anything to do with this power is a matter for future study.

The variable development of the ear and tragus in the different genera and species is indicative of corresponding variations in use. The broad, short ear of *Nyctalus* and *Pipistrellus* is accompanied by extensive sweat or oil glands[4] on the sides of the muzzle, which are connected with the highly developed nasal branches of the fifth nerve. In *Vespertilio* and *Myotis* the ear and tragus are larger, but the glands are less extensively developed. *Barbastella* and *Plecotus*, on the other hand, present a very remarkable extreme, both of ear and glandular development. Lastly, in *Rhinolophus* we see a simple ear without a tragus, but with well-developed antitragus, large

[1] In the families *Vespertilionidæ* and *Rhinolophidæ* the ethmoid bones depart so widely from the plan usual in mammals that a strong development of the sense of smell is suggested; see Harrison Allen, *Bull. Mus. Comparative Zoology* (Harvard, U.S.A.), x., 3, 160, 1882-83.

[2] Spallanzani, De Jurine, Spadone, etc. See Edward Newman, *Field*, 20th Dec. 1873, 628; J. McIntosh, *Zoologist*, 1850, 2814.

[3] The wing is richly supplied with blood, the circulation of which is assisted by rhythmically contractile, valvular veins, as described by Jones; and Leydig; see also for its structure, J. Schöbl, *Archiv für Mikrosk. Anat.*, Bd. vii., 1, pl. i.-iv., 1870.

[4] Hahn suggests that these "fatty pads" may have a protective value in preventing injury to the animal's head when it strikes an obstacle (*op. cit.*, 176).

auditory bulla, and a special nasal organ of sense, the "horseshoe." In all species the whiskers or vibrissæ are prominent.

Although it is difficult to explain the movements of bats by means of the five human senses, there is no proof of the existence of a sixth. Such a sense, if existing, might be one of direction, and might be located in the inner ear.[1] It must be remembered also that different senses may predominate in the various species, for it may be naturally supposed that the acuteness of each particular sense may vary in relation to the size, food, and general habits of each. In those bats, such as the Noctule and Leisler's, which fly in the subdued daylight of morning and evening rather than in the dark, the power of sight is probably considerable, as it may be also in exotic day-flying species. Indeed, the same authority, Mr Whitaker, who showed that in Natterer's Bat the eyes are not necessary for the performance of all normal movements, believes that the Noctule habitually hunts by eyesight; and that the Long-eared Bat relies largely on hearing and sight, especially the latter. On the other hand, Mr Bruce F. Cummings finds the sense of sight weak, but that of hearing very acute in the Greater Horseshoe.

As regards hearing, it is probable that this sense is frequently useful as a means of communication. Its importance to bats is indicated not only by the variable and remarkable development of the ear, but by the great mobility and independence of this organ. It is indeed inconceivable that creatures which, like some bats, are rarely silent should have no perception of the voices of their fellows; and indeed a young bat calls for its mother as persistently as any other young animal. Most experiments on the hearing of bats are subjected to the difficulty that, the cries of these animals being pitched on a very high scale, their auditory organs are almost certainly attuned accordingly. It is a well-known fact that their ordinary cries, although very perceptible to some human ears, are to others quite inaudible, especially to those of people of mature age. The gamut is, in fact, fixed above that to which human ears are attuned.

A captive Noctule, when it had become accustomed to its novel surroundings, took no notice of such (to human ears) loud

[1] Hahn, *op. cit.*, 191.

noises as thunder, but always started at the tearing of paper, and never ignored any sound approaching a chirrup or a click. At the latter sounds it would invariably awake from sleep, and they were always used to attract it to its food. High musical notes invariably attracted it, whereas low ones, however loud, had no perceptible effect.

According to Herr Herbert Elias,[1] the shrillness of the cries of bats has an intimate connection with the structure of the larynx. The musculature is very powerful and the glottis short, the latter being the main cause of the shrill cries.

Bats of many kinds have frequently been kept in **captivity,** and with varying success. Spallanzani, for instance, reared young ones on goat's milk. Few species show any naturally exaggerated fear of man when captured, and the majority rapidly accustom themselves to their new conditions; so much so indeed, that when well fed they become lazy and slow to take wing. The Horseshoes, however, were regarded as intractable, and had never been kept alive for any length of time, until Mr Coward, after three weeks' coaxing, induced them to feed satisfactorily. Others, as the Long-eared, the Noctule, Leisler's Bat, and the Pipistrelle—one of which Mrs S. C. Hall[2] is said to have preserved in health for over two years—and, as shown above, the Mouse-ear of continental Europe, are easily kept in health, have in some cases given birth to their young, and prove pets of considerable interest. In warm weather their appetite is prodigious, and an adult Mouse-ear, according to Messrs Rollinat and Trouessart,[3] is capable of devouring a thousand house-flies in a night and fifteen hundred in the night following: sixty-seven large grasshoppers were eaten at a meal, and eighty more followed during the ensuing night. The difficulty of supplying a number of captives with food was overcome by these authors by the help of the common cockroach, with the result that the bats brought forth and reared their young in perfect health, and after affording materials for the interesting observations already summarised, were released and took

[1] Gegenbaur's *Morphologisches Jahrbuch*, xxxvii., i., 70-119, 1907, with plates.

[2] *Vide* Newman, *Field*, 27th Dec. 1873, 656.

[3] These authors ingeniously moderated the appetite of their captives in winter by keeping them out of doors in a temperature so low as to induce torpidity.

wing—both young and old—none the worse for their captivity. Other species appear to be no less voracious; thus Dobson[1] mentions a fruit-bat which consumed food of twice its own weight in three hours.

The behaviour of bats when in captivity is in many ways of much interest, their actions being much influenced by their habits while in a state of nature. A bat rarely thinks of looking for a mealworm, even if it be struggling close under it on a table, thus suggesting the inference that an insect missed is an insect lost; but it will eat one if it accidentally touches its mouth or head. When first offered moths or mealworms in captivity, the various species behave very differently. Some, such as the Noctule, Leisler's, or the Pipistrelle, have no hesitation in feeding, but others, evidently not expecting to eat while resting, seem at first incapable of grasping the situation and appreciating the meaning of the objects offered to them.[2] The Whiskered Bat is at such times a particularly shy feeder, and appears to gain no information whatever from the sight or smell of a mealworm, although Mr Oldham found that the attachment of a pair of moth's wings to the worm has driven the lesson home. Even the Pipistrelle, which readily accustoms itself to captivity, has been known to insist on the unnecessary inconvenience of pouching a small insect eaten while resting on a flat surface.

There is nothing to guide us as to the possible age attained by bats, except the statement quoted above that a captive Pipistrelle lived in the possession of Mrs Hall for two years. From the known facts of their breeding habits it may, however, be argued that in Britain bats must, if the numbers of their species are to be kept up, reach a minimum of at least four years. The production and rearing of three young ones by a pair of bats (the first born when the parents are two or even three years old) occupies, if the number at a birth be but one, a period of about three years, and it is very doubtful if such a number would be sufficient to compensate for the admittedly large death-rate existing amongst wild animals. Where two at a birth is the rule, the period in question should be sufficient to

[1] *Catalogue of Chiroptera*, 83.

[2] The Long-eared is particularly easy to keep in captivity, since it readily searches for and seizes its food.

maintain the numbers, and these facts form a valuable commentary on Mr Moffat's views on the extermination by lack of fertility at the outskirts of the geographical range of a species.

The following key to the characters of British bats will, it is hoped, prove useful :—

A KEY TO BRITISH BATS.

I. EXTERNAL CHARACTERS:

I. WITHOUT NOSE-LEAF :—

1. *Ears separated—*

(A) External ear-border terminating under the angle of the mouth—

(A) Post-calcarial lobe prominent—

(a') Tragus broadest at apex. *NYCTALUS* p. 52

(α) Size larger, forearm rarely under 49 mm.. *N. noctula* . . p. 58

(β) Size smaller, forearm rarely over 44 mm. . *N. leisleri* . . p. 83

(b') Tragus broadest at centre *PIPISTRELLUS pipistrellus* p. 103

(B) Post-calcarial lobe insignificant *VESPERTILIO serotinus* p. 130

(B) External ear-border terminating under the base of the tragus . *MYOTIS* . . p. 140

(A) Posterior margin of interfemoral membrane not fringed—

(a') Ears moderate; when laid forward not extending beyond nose-tip—

(α) Calcar extending three-quarters way from ankle to tail . . *M. daubentoni* . p. 143

(β) Calcar extending halfway from ankle to tail *M. mystacinus* . p. 158

(b') Ears long; when laid forward extending far beyond nose-tip . . *M. bechsteini* . . p. 172

(B) Posterior margin of interfemoral membrane fringed . *M. nattereri* . . p. 178

2. *Ears united at base—*

(A) Ears very long, much longer than head (about 34-38 mm.) . . *PLECOTUS auritus* p. 194

(B) Ears of moderate length (about 13-16 mm.) . . . . *BARBASTELLA barbastellus* p. 212

II. WITH NOSE-LEAF . . . . *RHINOLOPHUS* p. 225

1. Size larger, forearm 50-55 mm. . . *R. ferrum-equinum* p. 228

2. Size smaller, forearm 34-39 mm.. . *R. hipposideros* . p. 250

II. TEETH AND SKULLS:

I. NASAL CARTILAGES WELL DEVELOPED :—

1. *Four functional teeth* **in tooth-row** *behind upper canine—*

(A) No rudimentary cheek-teeth . . *VESPERTILIO serotinus* p. 130

(B) A minute tooth internal to tooth-row between canine and first grinder.

(A) First lower grinder minute, its tip very much lower than summit of third; upper surface of rostrum concave, and facial profile descending abruptly to nasal region . . *BARBASTELLA barbastellus* p. 212

(B) First lower grinder large, almost equal in height to third; upper surface of rostrum convex, and cranial profile a gradual slope . . *NYCTALUS* . p. 52

(a′) Outer upper incisors almost double inners in section; greatest length of skull about 19 mm. . *N. noctula* . . p. 58

(b′) Outer upper incisors almost equal to inners in section; greatest length of skull about 15 mm. . *N. leisleri* . . p. 83

2. *Five functional teeth* **in tooth-row** *behind upper canine—*

(A) Five teeth **in tooth-row** behind lower canine . . . . *PIPISTRELLUS pipistrellus* p. 103

(B) Six teeth **in tooth-row** behind lower canine . . . . *PLECOTUS auritus* p. 194

3. *Six functional teeth* **in tooth-row** *behind upper canine—*

(A) Upper *pm.* II. smaller, its tip about reaching cingulum of *pm.* I. :—

(A) Size larger, greatest length of skull about 15 mm. . . *M. daubentoni* . p. 143

(B) Size smaller, greatest length of skull about 13 mm. . . *M. mystacinus* . p. 158

(B) Upper *pm.* II. larger, its tip reaching well above cingulum of *pm.* I. :—

(A) Upper *pm.* II. about equalling *pm.* I. . . . . *M. nattereri* . . p. 178

(B) Upper *pm.* II. distinctly smaller than *pm.* I. . . . . *M. bechsteini* . . p. 172

II. NASAL CARTILAGES AND UPPER INCISORS RUDIMENTARY . . . . . *RHINOLOPHUS* p. 225

1. Greatest length of skull about 24 mm.. *R. ferrum-equinum* p. 228

2. Greatest length of skull about 16 mm.. *R. hipposideros* . p. 250

VESPERTILIONIDÆ.

TYPICAL INSECT-EATING BATS.

THESE are bats without a nose-leaf; with a distinct tragus; with a long tail and large interfemoral membrane; without palatal processes to the premaxillæ, so that the bony palate is defective anteriorly and the upper incisors are divided in their midst by a wide space; without expansion of the nasal bones.

The arrangement and classification of the Vespertilionidæ followed in the present volume differs widely from that of Bell. The changes may be indicated by placing the two systems side by side:—

Bell's system of 1874:—		*System of present work:*—
SCOTOPHILUS NOCTULA	becomes	NYCTALUS NOCTULA.
S. LEISLERI	„	N. LEISLERI.
S. PIPISTRELLUS	„	PIPISTRELLUS PIPISTRELLUS.
S. SEROTINUS	„	VESPERTILIO SEROTINUS.
VESPERTILIO BECHSTEINII	„	MYOTIS BECHSTEINI.
V. NATTERERI	„	M. NATTERERI.
V. DAUBENTONII	„	M. DAUBENTONI.
V. MYSTACINUS	„	M. MYSTACINUS.
PLECOTUS AURITUS	remains	P. AURITUS.
BARBASTELLUS DAUBENTONII	becomes	B. BARBASTELLA.

From the above list two doubtfully British species have been omitted: the specific names of the remainder will be discussed under their own headings. As regards the generic names, *Scotophilus* was based by Leach (*Trans. Linnean Soc.*, London, xiii. 71-72, 1822) on *S. kuhlii*, a species quite different from any of those mentioned above. It was, therefore, employed in error by Bell. *Vesperugo* of Keyserling and Blasius, a substitute for *Scotophilus*, has been shown by Mr G. S. Miller to be inadmissible in any sense in zoology (see under genus *Nyctalus*).

In default, then, of the present arrangement, it is entirely open to question what generic term could be used, and in any case the trend of modern opinion is strongly against the retention in one genus of two such dissimilar animals as *serotinus* and *noctula*. If the separation of *noctula* and *leisleri* from true *pipistrellus* be refused, the generic name *Nyctalus* must, by the laws of priority, be applied to all three; but this question will be treated below. The transference of the name *Vespertilio* from the group of bats with thirty-eight teeth, as used by Bell, to that with thirty-two, is due, as is the rest of the present system, to the researches of Mr Miller, who showed (*Ann. and Mag. Nat. Hist.*, October 1897, 379-385) that much of our previous classification and nomenclature was based either upon laxity or upon intentional disregard of the laws of priority. Mr Miller remarks that Linnæus's genus *Vespertilio* (*Systema Naturæ*, I., x., 31-32, 1758), included seven species—*vampyrus*, *spectrum*, *perspicillatus*, *spasma*, *leporinus*, *auritus*, and *murinus*, only two of which, *auritus* and *murinus*, are European. As a non-exotic species illustrating most closely the original meaning of the author should be retained as the type of the genus, one of these two must be selected. The species *auritus* was removed to the genus *Plecotus* by Geoffroy in 1818 (*Description des Mammifères . . . en Égypte*, 112). Thus *murinus* is left as the type of the genus *Vespertilio*. The true *Vespertilio murinus*, however, is a totally different animal from the one formerly known by that name. To understand the matter fully it is necessary to refer to the two editions of the *Fauna Suecica*, in the first of which Linnæus mentions only one bat, the "Läderlapp," "Flädermus," or "Nattblacka." This he calls "*Vespertilio caudatus, naso oreque simplici*" (No. 18, p. 7, 1746). In the second edition two species are mentioned, No. 18 of the first edition (here numbered 2) and No. 3, the Long-eared Bat '*Vespertilio auritus naso oreque simplici, auriculis duplicatis capite majoribus*' (pp. 1-2, 1761). These had already received binomial names, *Vespertilio murinus* and *V. auritus* respectively, in the tenth edition of the *Systema Naturæ*, where the following diagnosis of *V. murinus* is given: "*V. caudatus, naso oreque simplici, auriculis capite minoribus*" (p. 32, 1758). In the second edition of the *Fauna Suecica* the teeth of *V.*

murinus are thus described:[1]—"Dentes primores superiores 6, acuti, distantes. inferiores 4. acuti contigui. Laniarii superiores 2. anteriore majore. inferiores 3. antico maximo. Molares utrinque 3. tricuspidati."

It thus appears that the *Vespertilio murinus* of Linnæus, the type of the genus *Vespertilio*, is a common Skandinavian bat with ears shorter than the head, and with the dental formula—

$$i\,\frac{2-2^{2}}{3-3},\quad c\,\frac{1-1}{1-1},\quad pm\,\frac{1-1}{2-2}\quad m\,\frac{3-3}{3-3}=32.$$

The only known Skandinavian bats which combine these characters are the members of the group to which *V. serotinus* belongs, and which are commonly known as *Vesperus* in Europe and *Adelonycteris* in America, but to which Mr Oldfield Thomas applied Rafinesque's name, *Eptesicus* (*Proc. Zool. Soc.*, London, 1896, 791, 1st April 1897).

The identification of the species *murinus* amongst the Skandinavian members of the genus *Vespertilio*, although a matter of considerable difficulty, does not affect the use of the generic name. Nilsson (*Skandinavisk Fauna, Däggdjuren*, 17-20, Ed. I., 1847) decided that it must have been the bat to which Natterer later gave the name *discolor*. He therefore placed the latter in the synonymy of *V. murinus* of Linnæus, and reinstated Bechstein's name *myosotis* (correcting it to *myotis*), for the *Vespertilio murinus* of Schreber. Nilsson did not recognise *Vesperugo* as distinct from *Vespertilio*. Hence he said nothing in regard to the tenability of the generic names. Ten years later, Blasius (*Fauna Deutschlands, Säugethiere*, 74, 1857), though admitting that the *Vespertilio murinus* of Linnæus could not be the bat commonly known by that name, considered the species undeterminable, and therefore reasoned that the name first applied to it might afterwards be properly used by Schreber in a different sense. Thus Blasius continued to apply the name *Vespertilio* of Linnæus to the genus to which he had restricted it eighteen years before, notwithstanding the fact that, according to his own statement, it could not be

[1] In the first edition the dental formula is the same, except that the lower incisors are said to be five in number, an error corrected in the second edition.

[2] In Linnæus's statement the figures 4 and 6 are evidently transposed.

made to include any of the Linnæan species. Lilljeborg (*Sveriges och Norges Ryggradsdjur*, i., 124-126, 144, 1874) followed Blasius, insisting that it is impossible to determine whether Linnæus's bat is the species afterwards called *Vespertilio discolor* by Natterer, or that called *Vespertilio nilssoni* by Keyserling and Blasius, but, contrary to the opinion of Nilsson, he favoured the latter. Lilljeborg, although aware of Blasius's mistake in applying the generic name *Vespertilio* to a group containing no species known to Linnæus, concluded that as the error had become time-honoured, it were better uncorrected.

Mr Miller concludes that, "Notwithstanding the inconvenience to which such a course leads, there can scarcely be any valid reason for rejecting the identification of Linnæus's *Vespertilio murinus* made by Nilsson. The doubt admittedly lies between two species, one of which he deliberately chose with all the facts before him. As nothing in the original description is in any way discrepant with this determination, it should be adopted."

Genus NYCTALUS.

1825. NYCTALUS, T. E. Bowdich, *Excursions in Madeira, etc.*, 36; based on *N. verrucosus* of Bowdich, antedating *Pterygistes madeiræ* of Barrett-Hamilton, *Ann. and Mag. Nat. Hist.*, Jan. 1906, 99.

1829. PTERYGISTES, Jakob Kaup, *System der Europäischen Thierwelt*, i., 99, 100; based on *Vespertilio "proterus et leisleri."*

1839. VESPERUGO, A. Graf von Keyserling and J. H. Blasius, Wiegmann's *Archiv für Naturgeschichte*, i., 312 (part); based on *Vespertilio serotinus* of Schreber and eleven other species (see below).

1842. NOCTULINIA, J. E. Gray, *Ann. and Mag. Nat. Hist.*, Dec., 258; based on "*N. proterus* and *N. fulvus*."

1856. PANUGO, F. A. Kolenati, *Allgemeine deutsche Naturhist. Zeitung* (Dresden), Neue Folge ii., 131 and 172; based on *leisleri* of Kuhl, and *noctula*, i.e. *La Noctule* of Daubenton.

1878. VESPERUGO, G. E. Dobson, *Catalogue of the Chiroptera in the Collection of the British Museum*, 183 (part); included also PIPISTRELLUS, VESPERTILIO, and others.

1893. NOCTULINIA, Harrison Allen, *Proc. U.S. National Museum*, xvi., 30, footnote.

Classification and Synonymy:—Mr Miller has shown that the genus *Vesperugo* of Keyserling and Blasius, as originally defined, is inadmissible. It included twelve species: *serotinus*, *discolor*, *nilssoni*, *savii*, *leucippe*, *aristippe*, *noctula*, *leisleri*, *kuhlii*, *albolimbatus*, *nathusii*, and *pipistrellus*. These were



DORMOUSE. ($\frac{2}{3}$ natural size.)

arranged in two subgenera—*Vesperugo* including the thirty-four-toothed species, and *Vesperus* those with thirty-two teeth. The subgenus *Vesperus* is exactly equivalent to the restricted genus *Vespertilio* of Linnæus, to the genera *Eptesicus* of Rafinesque and *Cnephæus* of Kaup, all of which antedate it. Apart from this, however, it would be necessary to find the type of the genus among the species referred by the authors to the typical subgenus. These represent two modern groups—the first consisting of *noctula* and *leisleri*, the second of the remaining thirty-four-toothed species. Each of these groups had been named by Kaup ten years previously. Therefore each of the constituent parts of the genus *Vesperugo* was provided with a tenable name at the time when the composite genus was formed.

The segregation of the *noctula-leisleri* group has long been urged by technical naturalists, on the grounds of their generally heavy build and long narrow wing, with reduced fifth metacarpal. It has even been recently advocated by a field naturalist, Mr C. B. Moffat, who contends that (*Irish Naturalist*, 1905, 104) the very wide difference shown to exist between the feeding habits of these bats and those of the Pipistrelle must be correlated with some important internal differences, a strong argument for generic separation. This was first attempted by Gray, whose genus *Noctulinia* was merely characterised as "with the feet quite free, the wing being only attached to the ankle; they are otherwise like *Scotophilus*," and consequently contained more species than *Nyctalus*, as used here; it was adopted by Blyth and Jerdon (see under synonymy of *N. noctula*). In 1893 the genus was for the first time accurately diagnosed in its present scope by Harrison Allen, but the name which he proposed for it is clearly antedated by Kaup's *Pterygistes* and Bowdich's *Nyctalus* (see Dr Andersen, *Ann. and Mag. Nat. Hist.*, May 1908, 434), both recently unearthed from oblivion. The present arrangement was at first rejected by Mr Thomas (*Zoologist*, 1898, 100), then reluctantly accepted (*Ann. and Mag. Nat. Hist.*, July 1901, 34), and now seems likely to meet with universal approval.

The genus *Nyctalus* includes two British species (*N. noctula* and *N. leisleri*). These are remarkable for their powerful, swift-like flight, and the fact that, unlike the Pipistrelle, which

flies all night, they, in the words of Moffat, "cram themselves to bursting-point, either once or twice in the twenty-four hours, during a 70-minutes' career of mad excitement among the twilight-flying beetles and gnats."

The genus is of wide **distribution,** having representatives allied to *N. noctula*—viz., in Japan, *N. lasiopterus* (Schreber), with the forearm measuring 60 or more mm.; central and south-eastern Europe,[1] *N. maximus* (Fatio), a mysterious giant of undetermined status (see Mr Miller, *Proc. Biol. Soc.*, Washington, 13th June 1900, 156), with the forearm of 68 mm. and remarkable skull; Sumatra, *N. sumatrana* (Cuvier[2]); China, *N. plancyi* (Gerbe); the Himalayas, *N. labiata* (Hodgson); and Mozambique, *N. macuanus* (Peters); the last four very little known. Allied to *N. leisleri* are *N. stenopterus* (Dobson) of Borneo and Malaysia, a very distinct dusky bat with the forearm of about 37 mm.; my *N. montanus*, of the Himalayas, and *N. verrucosus* (Bowdich), antedating my *N. madeiræ*, of Madeira, of size similar to *leisleri*, but with distinct crania; and *N. azoreum* (Thomas), of the Azores, a small form, with the forearm varying from 35-39 in males to from 39-41 mm. in females.

The most nearly allied genera (see Winge, *Jordfundne og nulevende Flagermaus (Chiroptera) fra Lagoa Santa, Minas Geraes, Brasilien*, in *E. Museo Lundii*, ii., 1, Kopenhaven, 1893) are *Pipistrellus* and *Barbastellus*, described below: *Chalinobus*, of the Australian and Ethiopian regions, with fleshy lobule to the lower lip; *Scotophilus*, of the Ethiopian, Oriental, and Australian regions, with only thirty teeth; *Harpyiocephalus*, of the Oriental region, with tubular nostrils; the long-eared *Otonypteris*, from N.E. Africa and the Himalayas; *Nyctophilus*, with thirty teeth and small nose-leaf, from Australia; *Lasiurus*, of North and South America, with four mammæ and hairy interfemoral membrane; and *Antrozous*, with remarkable muzzle, and only four lower incisors, of North America.

The **generic characters** are as follows:—The **body** is large and heavily built.

[1] Not found in Switzerland recently (see Mottaz, *Bull. Soc. Zool.*, Geneva, 15th Nov. 1908, 150.

[2] Stated to be of Cuvier, but I have not been able to find the original description.

The **head** is broad and flat; the mouth wide; the muzzle short and obtuse, the width of the face being increased by a number of prominent glandular swellings on each side between eye and nostril. The side of the head as far back as the ear and upwards to above the eye, together with the terminal portions of the muzzle, is very thinly covered with hair. The nostril is tumid at its upper and inner margins, and slightly channelled on its outer side; the pair project outwards and downwards, with a concave space between them. The lower lip has a thick triangular mental plate. The upper lip has a thick rounded border, and beyond a deep groove, interrupted only at each angle of the mouth by a fold of skin connected with the ear. The eye is, for a bat, moderately prominent, and situated between the gland and the ear (Plate IV., Fig. 1, p. 60).

The **ears,** widely separated, are thick, broadly rounded above, when flattened out nearly as broad as long, and extending very little beyond the eyes when laid forward: the outer margin of each is convex and reflected backwards, notched below the tragus with a thickened convex lobe in front of the notch, and terminating anteriorly behind the angle of the mouth, considerably in front of the base of the tragus; the inner margin is nearly straight above, convex, and turning inwards below, so as to form a moderately rounded basal lobe. The tragus is short, curved inwards, expanded above but constricted at its centre, so that it is broadest near the top, which forms a distinctly rounded or reniform head, broad, rather thick, and covered with numerous papillæ (Fig. 2, Nos. 1 and 2, p. 7).

The **wing,** attached to the middle of the sole, is large, long, and narrow, the fifth metacarpal being considerably shorter than the third. The post-calcarial lobe is well developed, and the interfemoral membrane ends posteriorly in a salient angle. The tail is much shorter than the head and body, and projects very little beyond the margin of the interfemoral membrane. The thumb is short, and has at its base a small callosity; the foot is thick; the toes are strong, and well developed (Plate VII., Fig. 1, p. 86: Plate IX., Fig. 1, p. 126).

There is a single pair of **mammæ,** situated in the pectoral region.

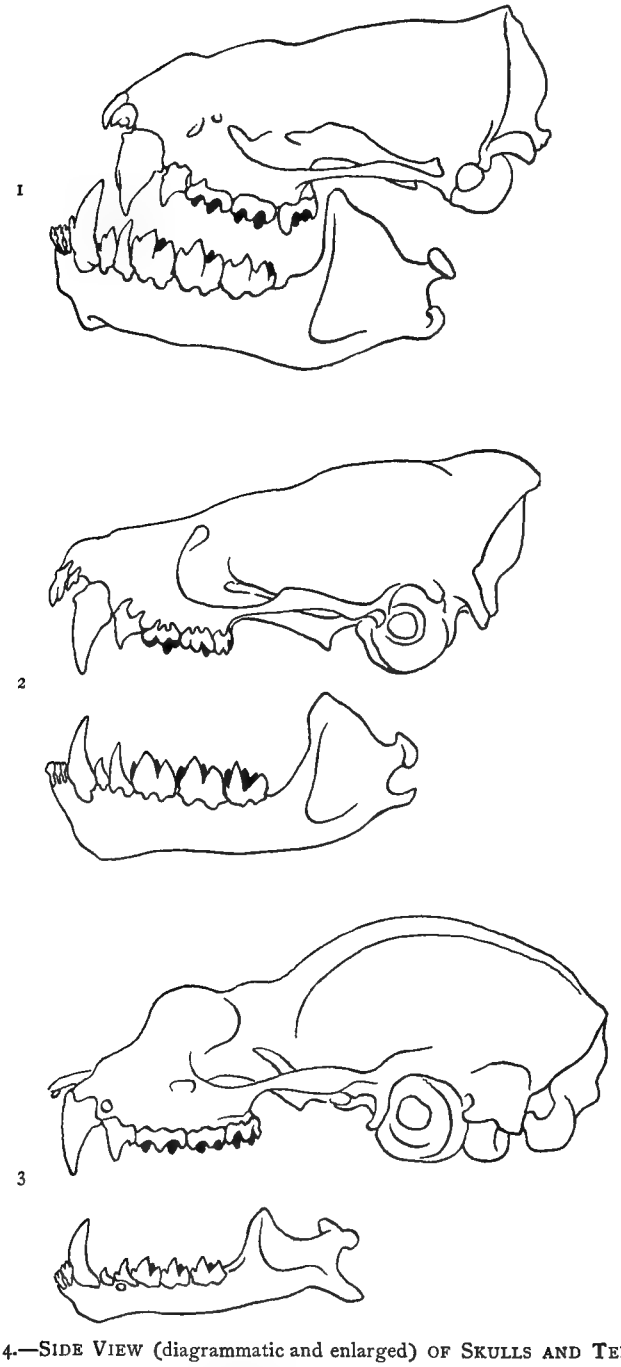


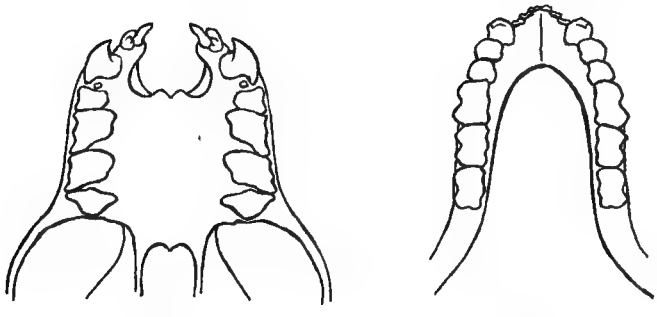
FIG. 4.—SIDE VIEW (diagrammatic and enlarged) OF SKULLS AND TEETH OF
1. *Nyctalus noctula.* 2. *Vespertilio serotinus.*
3. *Rhinolophus ferrum-equinum.*

The **skull** is massive and flat; the brain-case angular; the nasal region somewhat inflated; the premaxillary gap large, somewhat pointed above, deeply rounded below; the zygomata are moderately flattened; the cranial crests not prominent; the auditory bullæ moderately large (Fig. 4, No. 1, p. 56).

There are thirty-four **teeth** (Fig. 5), arranged as—

$$i\,\frac{2-2}{3-3},\quad c\,\frac{1-1}{1-1},\quad pm\,\frac{2-2}{2-2},\quad m\,\frac{3-3}{3-3}.$$

The upper incisors are arranged in pairs, inclined inwards, and separated by the wide interval of the premaxillary gap in



1 2

FIG. 5.—DIAGRAM OF ARRANGEMENT OF TEETH IN Genus *Nyctalus*.
(1) Upper, and (2) Lower Jaw.

their midst: the outer of each pair lie close and parallel to, but are shorter than the inner. The anterior upper premolar is minute, and lying in the internal angle between the canine and the posterior premolar, which meet externally, is invisible from without.

According to the best authorities, this genus represents the most specialised form of the *Chiroptera*, amongst which it is nowhere excelled in power of flight; a remarkable change of opinion, since in 1878 the leading authority of the day—Dobson (*Catalogue of Chiroptera*, 100)—wrote that "From whatever point of their structure they may be considered, the Rhinolophidæ are evidently the most highly organised of insectivorous Bats."

THE NOCTULE, OR GREAT BAT

NYCTALUS NOCTULA (Schreber).

1760. LA NOCTULE, L. J. M. Daubenton in E. L. le Clerc, Comte de Buffon's *Histoire Naturelle*, viii., 128-129, 135-137, pl. xviii., fig. 1 ; also *Mém. de l'Acad. Roy. des Sci.*, 380, pl. ii. (15), fig. 1, 1759, published 1765 ; described from France.

1775. VESPERTILIO NOCTULA, J. C. D. von Schreber, *Die Säugthiere*, i., pl. lii., 166-167, evidently naming Daubenton's *La Noctule ;* Bingley ; Pennant ; Donovan ; Fleming ; Jenyns ; Bell (ed. 1) ; Clermont ; Newman.

1776. VESPERTILIO LARDARIUS, P. L. S. Müller, *Natursystems Supplements und Register Band*, 15, naming Schreber's *Speckmaus*, *i.e.* V. NOCTULA, as above.

1776. GREAT BAT, Thomas Pennant, *British Zoology* (ed. 4), i., 128, pl. xiii., No. 38.

1789. VESPERTILIO ALTIVOLANS, Gilbert White, *Selborne*, letter xxxvi. to Thomas Pennant, September 1771 ; described from Selborne, England.

1789. VESPERTILIO MAGNUS, John Berkenhout, *Synopsis of the Natural History of Great Britain and Ireland*, ii., naming Pennant's *Great Bat.*

1806. VESPERTILIO SEROTINUS, Isidore Geoffroy, *Ann. du Mus. d'Hist. Nat.*, viii., 194, pl. 46, fig. 1 ; transference of name in error.

[1812. VESPERTILIO AURICULATUS, John Walker, *Essays on Natural History*, 472 ; described from Edinburgh, Scotland, but only doubtfully referable to *N. noctula.*]

1816. VESPERTILIO MAJOR, W. E. Leach, *Systematic Catalogue of the Specimens of the Indigenous Mammalia and Birds that are Preserved in the British Museum, etc.* (London), 5 ; renaming *V. noctula*, but without description.

1819. VESPERTILIO PROTERUS, Heinrich Kuhl, *Ann. der Wetterauische Gesellschaft für die gesammte Naturkunde*, iv., 41 ; renaming Daubenton's *La Noctule.*

1826. VESPERTILIO LAICOPTERUS, J. E. Gray, *Zoological Journal*, ii., 109 ; included as a synonym of *Vespertilio noctula ;* perhaps a misprint for *lasiopterus.*

1827. VESPERTILIO FERRUGINEUS, C. L. Brehm, *Ornis* (Jena), iii., 26 ; described from Jena, Germany.

1829. PTERYGISTES PROTERUS, Jakob Kaup, *System der Europäischen Thierwelt*, i., 100.

1838. SCOTOPHILUS NOCTULA, J. E. Gray, *Mag. Zool. and Bot.*, 497 ; MacGillivray, Bell (ed. 2).

1839. VESPERUGO NOCTULA, A. Graf von Keyserling and J. H. Blasius, Wiegmann's *Archiv für Naturgeschichte*, i., 317 ; Blasius ; Fatio ; Dobson ; Harting, *Zoologist*, 1887, pl. iii., 167-171 ; Blanford ; Woodward and Sherborn ; Lydekker ; Millais, pl. vii.

1842. NOCTULINIA PROTERUS, J. E. Gray, *Ann. and Mag. Nat. Hist.*, Dec., 258.

1845. NOCTULINIA NOCTULA, Edward Blyth, *Journ. Asiatic Soc. Bengal*, xiv., 340 ; referring to T. Hutton's Mussooree specimens (see *Proc. Zool. Soc.*, London, 1872, 707) ; T. C. Jerdon, *Mammals of India*, 36, 1867 ; Harrison Allen, *Proc. U.S. National Museum*, xvi., 30, footnote, 1893 (diagnosis of genus).

1856. PANUGO NOCTULA, F. A. Kolenati, *Allgemeine deutsche Naturhist. Zeitung* (Dresden), Neue Folge, ii., 131, 172-174.

1869. VESPERUGO NOCTULA, var. MINIMA, Victor Fatio, *Vertébrés de la Suisse*, i., 58; described from Geneva, Switzerland: See Mottaz, *Bull. Soc. Zool.* (Geneva), 15th Nov. 1908, 151.

1897. PTERYGISTES NOCTULA, G. S. Miller, junior, *North American Fauna*, No. 13, 87, footnote; *Ann. and Mag. Nat. Hist.*, October 1897, 383-384; Oldfield Thomas, *Ann. and Mag. Nat. Hist.*, July 1901, 34; Johnston; Méhely; Cabrera; Millais, 61.

1898. PIPISTRELLUS NOCTULA, Oldfield Thomas, *Zoologist*, 100; Millais, 61.

La Noctule of the French; *die frühfliegende Fledermaus* of the Germans.

Noctule, from the French *noctule*, diminutive from the Latin *nox*, genitive *noctis*, *i.e.*, "night."

Local Names:—Rat Bat of Durham (Roebuck, *Naturalist*, 1886, 113), Cheshire (Oldham), Leicester (Montagu Browne), Buckingham and Berkshire (Cocks, *Zoologist*, 1878, 334), and probably of other counties. Ree rot, *i.e.*, rere or rear rat (see "rere mouse" under PIPISTRELLE) of Gloucester (Newstead). Ystlum (pronounced "slim") Fawr, *i.e.*, Great Bat of Wales (Forrest).

Distribution:—The Noctule, or bats closely resembling it, inhabits the wooded districts of boreal and transitional Europe and Asia, from sea-level to over 4000 feet (in the Alps), from south Scotland and Norway, Denmark, north Germany, and middle Russia, to the Mediterranean, Black Sea, Caspian, and Turkestan (Samarkand), with (?) Minorca (Barcelo), and Sicily (Blasius); and from Great Britain probably to eastern Siberia; but the exact limits of its range are very imperfectly known, as are those of the allied forms mentioned above (p. 54), upon which, or others, are probably based records of Noctules from Japan, China, Nepal, Sikkim, Kandahar, Ceylon, Singapore, Sumatra, Java, and Mozambique.

Throughout the south of **England**, from Norfolk to Cornwall (Cocks, *Naturalist*, (1), 1851, 37; Rodd, *Zoologist*, 1891, 347), but rare in Wight (More, *Journ. cit.*, 1894, 148; Wadham), *N. noctula* is a common species. Its flight may even be observed in the heart of London, above the Serpentine (Macpherson), or in many of the parks (Millais). It probably occurs in every county of **Wales**, where Forrest reports it from Flint, Montgomery, and Radnor; Newstead along the Dee Estuary; Coward and Oldham in Denbigh, Carnarvon (*Zoologist*, 1901, 53), and Anglesey; and Caton Haigh, in Merioneth (*Zoologist*, 1887, 293): in the latter county it loves the oak-covered hills, and in Carnarvon it is abundant at Nevin, right down to the sea-cliffs.

In the north it is widely distributed, and abundant as far as south, and probably central, Yorkshire, where it is found at an elevation of 700 feet, at Carperby in Wensleydale; but towards the north and west of the county it becomes less numerous, and Northallerton was its most northern known British locality (Bell) until Nelson and Roebuck

extended its range to Bishop Auckland and Newcastle-on-Tyne respectively, the latter the extreme northernmost limit of Durham (*Naturalist*, 1884-5, 202; 1886, 113 and 173; Harting, *Zoologist*, 1887, 260). In Lakeland, Macpherson, although denying its general distribution, placed its range as "at least as far north as our most southern limits," and particularly at Carnforth in Lancashire, and probably at Bowness-on-Solway in Cumberland. Harting, on the authority of Lee, records its occurrence at Kendal in Westmorland (*Zoologist*, 1887, 170).

For **Scotland** there was until recently no certain record, although Sir William Jardine stated that it had been seen about the river Annan in Dumfries (*Statistical Account of the Parishes of Applegarth and Sibbaldbie*, 1835, 175), and Fleming identified with it John Walker's *Vespertilio auriculatus*.[1] Of late years, Service (*Ann. Scott. Nat. Hist.*, 1896, 202) has on several occasions noticed darkly coloured bats flying high near Dumfries, and his description is suggestive of a member of the genus *Nyctalus*. The first actually known Scotch specimen, shot at Deune, on the Tay, in Perth, by Charles Eversfield, on 13th October 1904, was forwarded to Millais: the skeleton is in the Perth Museum (*Zoologist*, 1904, 425). A second was sent to William Taylor from Duffus, near Elgin, on 1st October 1909, and others are stated to have been seen about Elgin and Llanbryde, where there is probably a colony (*Ann. Scott. Nat. Hist.*, 1910, 52-53).

So far as is known, *N. noctula* is absent from all the Scotch islands, as well as from **Man** and **Ireland**, although Dobson at one time identified with it two bats, a male and female, procured from Tandragee, Co. Armagh, by Barrington (*Zoologist*, 1874, 4071-4074; Harting, *Zoologist*, 1887, 168). In 1878 the same authority cited them as "*V. leisleri*" (*Catalogue*, 215), but in 1889, writing to Barrington of some further Irish specimens, he thought that, if certain characters

[1] Unfortunately Walker's description of *V. auriculatus*, except that it clearly does not apply to a *Rhinolophus*, was not drawn up with sufficient exactness to be definitely applicable to any known Scottish species. It does not include any dimensions, and the thirty-two teeth and lanceolate tragus would refer rather to *V. serotinus*, which is not known to occur in Scotland, than to *N. noctula*. Alston evidently considered the description inexact, or he would not have connected it with *Myotis daubentoni* (*Fauna of Scotland*, 8), a species having thirty-eight teeth. On the whole, it seems better to let such laxly written descriptions remain unconnected with any particular species than to attempt a definite decision upon insufficient grounds. It may be interesting to transcribe the whole passage:—

"Auriculis duplicatis. Vespertilio auriculatus, caudatus, naso oreque simplici, auriculis duplicatis capite minoribus. . . . Descriptio maris. Dentes XXXII. numeravimus. Primores superiores 4 acuti distantes; inferiores 4 acuti contigui. Laniarii superiores 6: anticis maximis acutis; inferiores 6: anticis majoribus. Molares utrinque 6. Aures duplicatæ, capite multo minores. Exterior major ovata obtusa. Interior minor brevior lanceolata. Palmæ palmato-alatæ maximæ, pollice unguiculato. Plantæ pentadactylæ fissæ, digitis pilosis unguiculatis. Cauda geniculata, 6 articulis. Membrana juxta caudam, margine ciliato. . . ."

which he found in them were present "in the perfectly adult animal, then the Irish specimens represent either a new species, or a curious case of hybridization" (*sic*). The matter had not been settled at the time of Dobson's death, but de Winton compared these Irish with English individuals of *N. leisleri*, and found no difference between them (Alcock, *Irish Naturalist*, 1899, 170-1). After careful examination, I find myself entirely in agreement with de Winton, and in any case it is clear that there exists no evidence for the occurrence of the Noctule in Ireland.

It is possible that, as suggested to me by Moffat, this species may have recently extended its range in Britain. The idea can only be regarded as hypothetical, but the present distribution of the bat is consistent with a comparatively recent arrival. Its range on the continent of Europe brings it into contact with greater cold than it could experience in Scotland, and the absence of so widespread and powerful a flier from Ireland is intelligible on some such basis. Such a supposition would be in concord with its reputed rarity at Selborne in Gilbert White's time, its present abundance there, and its recent appearance in Scotland. Moffat ingeniously adds that the much shorter flying season reported by White would be natural in a species newly arrived, which as it became acclimatised might be supposed to extend its period of activity on the wing.

Distribution in time:—Bones of this bat have been found in cave deposits of pleistocene age at Banwell, Burrington Combe, and Hutton (Woodward and Sherborn).

Period of gestation:—Certainly not less than thirty-eight days (Daniell, *Proc. Zool. Soc.*, London, 1834, 129-132), but probably at least forty-nine; see above, page 33, and Whitaker on Pipistrelle.

Number of young, and **breeding season**:—There is rarely more than a single young one in Britain (see p. 80). It is born most usually towards the end of June.

Description:—The general form and appearance of the Noctule is typically that of its genus. The forearm is massive, the lower leg thick but short, the foot conspicuously powerful.

The **fur** is soft and long. The face is thickly furred from behind as far as the glandular prominences, and anteriorly the muzzle carries a few long hairs. Upon the upper surface of the wing the fur extends as far outwards from the body as a line drawn from the middle of the humerus to the knee-joint, and on both surfaces of the interfemoral membrane as far back as the middle point of the lower leg: on the under surface the wing is rather thickly clothed as far as a line drawn from the elbow to the knee-joint, and a band of fine short hair frequently, but not always, passes behind the forearm to the carpus. The inner side of the ear is covered with fine short hairs, which also appear upon the tragus, and sparsely upon the reflected outer margin of the conch.

The **colour** above and below is yellowish or golden, almost ochraceous, brown, very little lighter on the under surface; the hairs are almost unicoloured, the basal and concealed portions being only of a slightly lighter shade. The wing and foot are dusky; the lips, ear, and nose lighter. In the newly-born young, the wing and interfemoral membrane, the ear, muzzle, foot, and tail are pigmented nearly as deeply as in adults, but all those parts, including the forearm, which in the adult are covered with hair, are of a dull flesh colour. The eyes do not open until at least the twelfth day, and the hair, preceded by pigmentation, begins to make its appearance when the bat is about a fortnight old (Whitaker, in MSS.). After the hair has been acquired, the young at first are darker than the adults (Forrest, in MSS.).

I find no trace of **seasonal variation** or **moult**, but it is probable that, as with *N. leisleri*, the coat is pale and faded in early summer, and deepest and richest in early autumn just before hibernation. Old males are said to possess the brightest golden fur.

The **skull** is typical of the genus. It is characterised by a strong lambdoid, but, as a rule, weak sagittal crest; there is much individual variation in size and proportions (Fig. 4, No. 1, p. 56).

The **teeth** are shown in Fig. 6. The inner upper incisor is bicuspid in the young, but adults lose the small outer cusp. The outer upper incisor is much shorter than the inner, *but much broader in transverse section at the base:* its crown is hollowed out for the reception of the tip of the lower canine. *The lower incisors are crowded and overlap*, so that their broad crowns are oblique and parallel to the jaw.

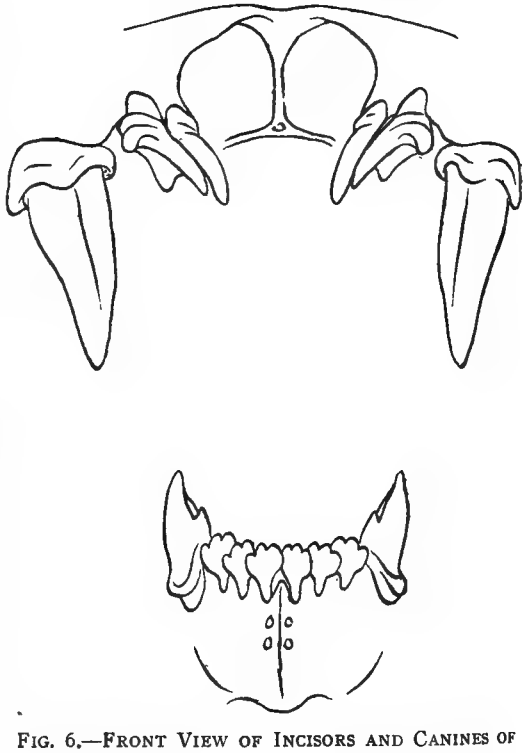


FIG. 6.—FRONT VIEW OF INCISORS AND CANINES OF *Nyctalus noctula* (enlarged and diagrammatic.)

Laver mentions an almost black specimen, and Norton others "pied with grey, also with black, and sometimes a light colour round the

neck" (*Midland Naturalist*, 1883, 151). Otherwise, **individual and geographical variation** appears chiefly in size, the larger forms showing a correlated development of the cranial ridges. In a large female from Devon the forearm measures 54, or fully 3 mm. above the average, but it is still far below that of *maximus*.

DIMENSIONS IN MILLIMETRES:—

	Head and body.	Ear, greatest length.	Tragus, greatest length.	Tail.	Lower leg.	Hind foot, without claws.	Forearm.	Thumb without claw.	Longest digit.	Metacarpal III.	Metacarpal V.	Greatest expanse of wings.*
Males.												
No. of Items	7	5	6	7	..	..	7	..	5	5	5	3
Maximum .	80	18	7	53	..	10 (juv.) to 12	51	..	..	..	..	375
Average .	77·5	17	5	49·5	17-18		50	7-8	87-96	46·5-50	36·5-39·5	..
Minimum .	76	16	4	43	..		49	..	..	.	..	353
Females.												
No. of Items	8	6	4	8	..	..	9	..	7	7	7	3
Maximum .	82	18	..	56	..	..	54	..	..	..	..	387
Average .	77		..	49	17-18	11-12	51·3	7-8	91-94	48-52	38-42	..
Minimum .	73	16	..	41	..	..	50	..	..	..	..	362

* Norgate (*Zoologist*, 1906, 26) gives the average of many as 14¼ inches, and the extremes as varying from 14⅛ to 15 inches.

The female is, on the average, the larger sex.

Proportionate lengths:—Foot, without claws, about ·64 to ·66 of lower leg; fifth metacarpal about ·79 to ·80 of third; lower leg about ·33 to ·34 of forearm, and about ·24 of head and body.

Skull:—Greatest length, 19; basal length in middle line, 14; palatal length in middle line, 7; from posterior border of m^3 to anterior border of canine, 7 to 7·5; same in lower jaw, 7 to 7·5; greatest breadth at zygoma, 12·75; posterior breadth, 12; breadth between orbits, 12·2; breadth at constriction, 5.

Very few published details of the **weights** of Noctules are available, but Aplin, who weighed two on 25th July, each of about 26 grammes, and one on 13th October of 35·44 grammes, found a considerable increase of weight in autumn (*Zoologist*, 1885, 344). The following (in each case converted to grammes) are of interest:—Two males, each 30·12

grammes (Gilbert White, letter xxxvi., to Pennant); 15·95 grammes (Fleming); a captive female, June, 17·72 grammes (Daniell); one, 28th April, 24·80 grammes (C. H. B. Grant); a female, 27th March, 38·88 grammes (Charbonnier).

Distinguishing characters:—The Noctule is an easy bat to identify. On the wing its dashing, lofty, swift-like flight is very distinctive, and is only approached by *N. leisleri*, which is, however, too small to be confounded with a mature Noctule. In the hand no species approaches its size, with the exception of the Greater Horseshoe, to be at once recognised by its nose-leaf and the absence of a tragus; and the Serotine, also a very different animal.

We are indebted to Daubenton for the first discrimination of this fine bat. He described it and figured the head so long ago as 1759, and Buffon subsequently gave it a place in his great work. The first notice of its occurrence as a British species is in Gilbert White's *Natural History of Selborne*,[1] in which it is mentioned three times, and its general appearance, early autumnal retirement, "very rancid and offensive smell," and lofty flight are subjected to criticism. It was the latter peculiarity which suggested to White the appropriate name of *Vespertilio altivolans*.

Other British writers were not slow to follow White, and we find the Great Bat or Noctule and its habits described with more or less precision in the works of Pennant, Bingley, Donovan, Fleming, and Jenyns. It appeared in both editions of Bell, who, himself a resident of Selborne, observed it for several successive seasons, probably on the very ground where it first attracted the attention of its venerable discoverer. Its habits are now fairly well known, thanks to the labours of a number of naturalists, amongst whom the names of George Daniell, George Dowker, John Wolley, and Messrs T. A. Coward, Charles Oldham, and Arthur Whitaker stand out most prominently.

The Noctule is a tree-loving species, existing in some abundance in the southern and midland counties of Great Britain, especially where there are old trees in sufficient numbers to provide it with secure retreats. It dwells gregariously in large companies in holes of trees or of buildings, and its

[1] Letters xxii., xxvi., and xxxvi., to Thomas Pennant, dated 2nd January 1769, 8th December 1769, and September 1771: original edition, 63, 75, 93-94, 1793.

presence is often betrayed by the excrement, which, as at Ragley, the seat of the Marquis of Hertford, may lie so thick as to darken the ground under some ancient resort.

From such holes, the entrance to which is often polished smooth by the frequent passing in and out of the occupants, the insertion of a flexible stick sometimes dislodges a surprising number of bats. For instance, Pennant states[1] that the Reverend Doctor Buckworth saw taken from under the eaves of Queens' College, Cambridge, one hundred and eighty-five in one night; on the second night sixty-three were taken, and on the third night two. From another colony, described from King's Lynn by Mr H. B. Booth,[2] nearly three hundred bats were seen to issue for their evening flight. It has been objected that, since there is no reason to believe that the bats were all subjected to the rigid examination necessary to determine the specific distinctions of these animals, it is probable that other kinds were mingled with them in these great congregations; but repeated observation by many naturalists has led to the belief that the present species rarely, if ever, occupies its retreats as a tenant in common with others, and moreover the occupants of many lesser yet thickly crowded Noctule dens have since been counted by reliable observers. Indeed, the species is so abundant that Frederick Bond[3] informed Edward Newman that he had observed no less than three or four hundred on the wing together.

Although preferring in summer to seek its retreat in the hollow cavities of trees, the Noctule is, as the above anecdote shows, by no means loth to creep under the eaves of houses, but, so far as I know, it has never been met with in caves, a statement,[4] that it breeds in the Mendip caverns of Somersetshire, being so contrary to the general experience that I hesitate to accept it without corroboration. In fact, it seems to be almost a rule with it to seek good winter quarters amongst houses or ruins. From these it issues forth nightly for a few weeks in the spring, but after a time forsakes them for an entirely arboreal life, returning, however, for its autumnal

[1] *British Zoology*, London ed. of 1812, I, 179. [2] *Zoologist*, 1905, 427-429.
[3] *Field*, 7th March 1874, 218. [4] Stanley Lewis, *Zoologist*, 1906, 69.

hibernation. In like manner, its feeding grounds change with the season, the choice of them and the presence or absence of the bats being no doubt determined by the distribution of the insects upon which they feed. At Dunham, in Cheshire, write Messrs Coward and Oldham, "at first these bats fly very high, squeaking and chasing one another around and above the tree-tops. During summer they frequent the open glades, generally flying high; but towards the middle of September they resort in great numbers to the water-meadows by the river Bollin, flying up and down alongside the park-wall, often not more than ten or twelve feet from the ground."

The general conformation of this bat is essentially adapted to the capture and mastication of beetles. Its broad muzzle and strong jaws are quite equal to the reduction of the larger kinds, such as the dor-beetle or the cockchafer, of which, according to the elder J. H. Gurney,[1] one has been known to consume as many as thirty in half an hour. The stubborn elytra are invariably cut off at the base and rejected, and these, where the bats feed thickly over water, have astonished an observer, ignorant of their habits, as they fell in showers on the surface.[2] In fact, so strong is this species that, as related below, it seems likely that it has but seldom need to call in the assistance of the interfemoral pouch, the mainstay of the smaller kinds. At all events, although he has seen the pouch used in captivity, thus showing that this species is not unacquainted with the habit, Mr Oldham, who has spent hours watching wild Noctules, has never once detected them in the act of pouching an insect; and Frank Norton,[3] although believing that the tail "is certainly brought very much into play," never succeeded in proving this, as in the case of the Whiskered Bat, which, he states, is easily caught *by the wing* when a beetle is suspended near its beat on a hook. On the other hand, Mr Whitaker informs me that on one occasion he deceived one into pouching a pebble thrown up to attract it. The bat carried the pebble a distance of some yards before dropping it with a splash into some water. This propensity of bats to mistake pebbles or other objects for their prey is well known; and an object

[1] *Zoologist*, 1874, 4153. [2] Thomas Ford, *Field*, 10th September 1898, 470.
[3] *Midland Naturalist*, 1883, 151-152.

thrown towards one, even when flying high, will often attract it within gunshot. It does not necessarily indicate, as Mr Whitaker suggests, that the bats hunt chiefly by eyesight. Mr Arthur Patterson[1] finds that a good mimicry of its shrill notes serves the same purpose, and he relates that, having on one occasion a slightly wounded one shrieking in his pocket, its companions came so near him that he could feel the whisk of their wings.

Besides beetles, this bat eats moths and lesser insects also when they come in its way, and it will certainly devour them freely in captivity. It is difficult, however, to prepare a precise list of the creatures upon which it preys, since digestion is very rapid and the contents of the stomach of shot specimens are usually in a highly disintegrated condition. Mr Coward noticed[2] a number flying low over the fields at the edge of the cliffs at Nevin, Carnarvonshire, their food being apparently the winged males of a species of black ant, and Mr J. Steele Elliott has observed them hawking mayflies over the river Severn.[3]

The flight of the Great Bat is, typically, high, straight and rapid, and it may often be seen careering with swifts or swallows at great elevations; but it is by no means tied to habit in this respect, and frequently manœuvres near the ground or occasionally dips towards a stream to seize its quarry. During the fine midsummer evenings, when the abundant cockchafers are humming on every side, it is in its glory. Then it flies high and straight, and its shrill, clear voice is heard as it passes overhead, interrupting itself only to dart at some insect, and then passing on. But an observer will not watch its actions long without noticing a movement which looks like the falling of a tumbler pigeon, with a consequent drop of about from one to six or eight feet. Sometimes this is repeated every few yards as long as the animal is in sight, and its meaning has been the subject of some discussion. The usual explanation is that the fall takes place with closed wings, and must be occasioned by the capture of some insect so large and intractable that the anterior joint of the wing, with its well-armed thumb, is

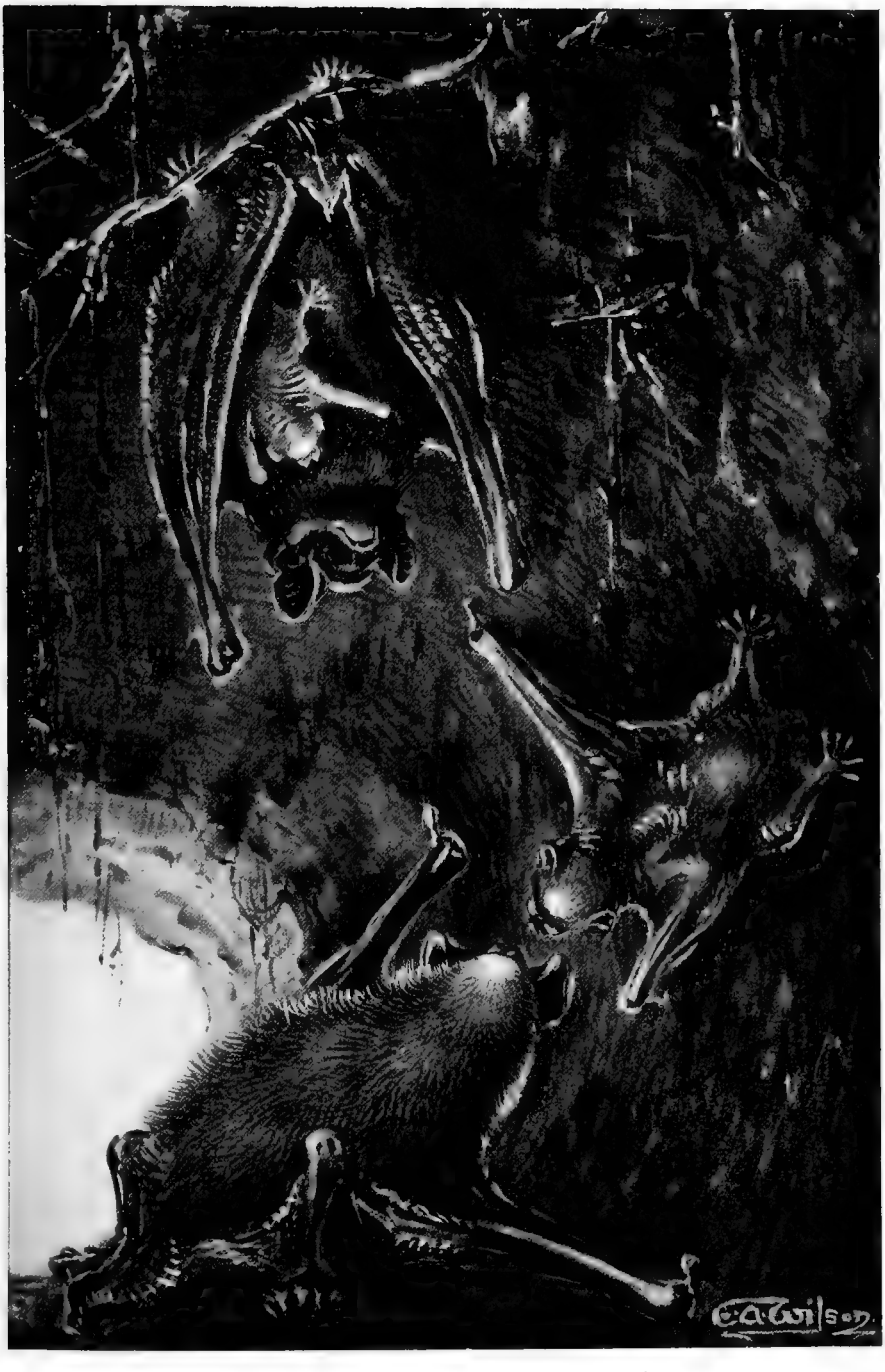
[1] *Zoologist*, 1898, 304. [2] *Ibid.*, 1901, 53. [3] *Ibid.*, 1901, 70.

required to assist in retaining it until masticated.[1] Proof of this contention is, however, not forthcoming, and it is noteworthy that Mr Oldham, who has spent hours watching Noctules under favourable conditions, both with the naked eye and with a strong glass, has never detected them using the thumb to rend asunder their prey. It seems clear, from the evidence of Messrs Coward, H. E. Forrest, J. G. Millais, and Oldham, that the plunge takes place obliquely downwards, both wings being clearly extended—a posture very different from a vertical fall, such as occurs when there is a loss of balance, as when one wing is broken by shot. My own conclusions are thoroughly in accord with the opinion[2] that the plunge is made after insects below and off the direct line of flight. The fact that it may take place not only downwards, but in an oblique direction, is indeed an almost proof positive of its objective. It is a falcon-like swoop, the tremendous force of which is illustrated by Mr Whitaker's[3] experience of a bat which, in pursuit of a pebble, struck a butterfly-net so violently as to break a wing and nearly dash the net from his hand.

Sometimes, however, food is not so readily obtained. With a cold east wind, or indeed a strong wind from any quarter, a change of hunting ground is required, and the Noctule may then be seen taking a humble and silent flight in some sheltered corner, fluttering about with half-closed wings, and appearing to be very little at home or, indeed, like itself; for instances are on record where several have been shot under the belief that they were of some unknown species.

Long ago Wolley graphically described[4] its flight as always strong, but varying "remarkably at different times, no doubt influenced, like that of the swallow, by the casual range of its prey; at one time it may be seen flying away, straight and swift, at a great height in the air, no more to appear that evening; at another it will be performing a great circle, returning perhaps once in five or ten minutes; or it may be flying low (and then I think silently) along the streets of a town: again it is wheeling round tall elms, in company with others

[1] See, for instance, Oxley Grabham, *Zoologist*, 1899, 131.
[2] *Trans. Caradoc and Severn Valley Field Club*, 1900 (Feb. 1901), 243.
[3] In MSS. [4] *Zoologist*, 1845, 953.



NOCTULE BATS. (Approximate natural size.)

of its own species, at the time of year when the small hairy cockchaffer . . . is swarming about them. Then its powers are seen to perfection, and the great advantage over the feathered tribes that it derives from the mammalian articulation of its wings is beautifully evident. . . . Its latest are by no means its lowest flights; even in November I have observed it at such a height, that I could hardly have seen it, had not my eye been directed to it by its cry. This is the cricket-like chirp which it always makes with incessant repetition when flying high: . . . it calls my attention to the animal when it is within a hundred yards or so, frequently giving me the first intimation of its presence: it is so readily distinguished by its peculiar cadence from the chirp of other bats, that however dark the evening, it gives me certain indications of the Noctule."

The habit of sometimes flying straight away and to a distance from its diurnal retreat may frequently have the effect of preventing the species from coming under attention in its actual home. Dowker,[1] for instance, although observing them issue from his house in Kent, whence they immediately took flight across the marshes, searched for them in vain on the wing in the immediate neighbourhood, to which they only returned at the conclusion of their flight.

It was long thought that the Noctule remains in activity for a shorter period than any other bat, coming out later and retiring earlier: White[2] never saw it abroad till the end of April, nor later than July; but this exceptionally short season at Selborne must have been due to causes other than hibernation, since subsequent observers have lengthened the flighting period until it is now known to include every month of the year, excepting only the latter part of December and January. No doubt its appearance in the spring and its retirement in the autumn depend to some extent on the mildness of the season, but Mr L. Buttress[3] has noticed it abroad in Nottinghamshire on 14th March, the thermometer

[1] *Zoologist*, 1889, 258.

[2] Letters xxii., xxvi., and xxxvi., to Thomas Pennant, dated 2nd January 1769, 8th December 1769, and September 1771.

[3] *Field*, 23rd April 1892, 585.

then standing at 40° Fahrenheit, and according to Mr Steele Elliott,[1] it flies commonly in Worcestershire towards the end of that month, the earliest which he ever saw on the wing having been active on 22nd February. Mr Oldham has detected it in flight on 18th, 20th, 8th, and 18th March in the years 1902 to 1905 respectively. In autumn the flying season seems to terminate ordinarily towards the end of October, during which month Mr O. V. Aplin has seen[2] it out in Oxfordshire in very cold weather, both foggy and frosty. More than one writer has reported[3] the flying of Noctules so late as the second week of November, but probably Mr G. T. Rope's observation[4] of the 28th of that month, and Mr Aplin's, as quoted by Mr Millais, of 3rd December, are the latest recorded.

So far as I am aware, Dowker[5] was the first Englishman to point out that the evening flight lasts only for about an hour. He watched the bats emerging from their winter quarters under the gable of his house early in May and June. The weather seemed to have little influence on their activity once they were in full flight, but at first only a portion of the colony appeared to be active enough to take wing. He counted only fourteen on 1st May, but the number increased to sixty-seven on 4th June and to one hundred and twenty on the 12th, after which they appeared in decreasing numbers, until in the middle of the month only one was visible. The time of their appearance varied from 7.50 to 8.15 P.M., the return of the first taking place at about 9, when, if many happened to be out, they came flying round their home like a cloud of bees, awaiting opportunity to enter. With unimportant variations, Dowker's statements are closely corroborated by Mr Booth,[6] who describes the appearance of the members of a large colony in small parties in the late April and early May evenings; their steady increase, until in early June the numbers leaving nightly became almost incredible, and later their rapid decrease, until in July

[1] *Zoologist*, 1904, 455. [2] *Ibid.*, 1885, 344.
[3] *E.g.*, Forrest, Steele Elliott, Henry Laver (specimen obtained on the 10th), Millais.
[4] *Zoologist*, 1891, 167. [5] *Ibid.*, 1890, 217; 1891, 305. [6] *Ibid.*, 1905, 427-429.

not a single bat would leave the dormitory, although crowds might be seen hawking in the air outside each evening. It appears, therefore, probable that a summer "camping out" season is a regular feature of the animal's annual routine. The order of leaving the den was very "curious. A loud squeaking would be heard for a minute or two near the inside of the hole; then a Noctule would appear, and launch itself into the air, followed in quick succession by four or five more. Then silence ensued for a minute or so, followed by the squeaking noises again, and another party of five or six would follow each other out. This mode of procedure would be carried on continuously. Silence, squeakings, and then bats in constant succession. Most of the 'parties' consisted of from five to eight individuals, though on occasions (particularly on evenings when the greatest number were leaving) I have seen as many as a dozen or more follow each other without a break, but this was exceptional. These small parties were called families by my friends, but they scattered off individually and in separate directions immediately they were clear from the hole." The bats were never detected returning to their den in autumn, although always there in the spring.

Working mainly in Cheshire, Messrs Coward and Oldham have added largely to our knowledge of the times of flight of this bat, and no account of its natural history could be regarded complete that did not include substantial quotations from their essays on the subject. In Cheshire, "on fine evenings," writes Mr Oldham,[1] "one's attention is often attracted by the shrill squeak of the Noctules which are flying in company with the Swifts, at an altitude difficult to estimate accurately, but certainly not less than from seventy to eighty feet. . . . As the light fades, the Bats descend to a lower level, and feed at a height of from fifteen to thirty or forty feet above the fields, pools, and open places in the woods. The crunching of their jaws as they masticate their insect prey may then be heard distinctly.

"The time at which the Noctule issues from its retreat does not always bear the same relation to the hour of sunset, and sometimes differs considerably on consecutive evenings. Wind,

[1] *Zoologist*, 1901, 51-59.

temperature, and other atmospheric conditions, rather than the actual hour of sunset, probably determine the time at which the Bats emerge, and the duration of their flight. Rain, if not heavy, does not incommode them whilst feeding, but if the night be cold and windy few or none will be seen. It is probable that individual Noctules do not always resort to the same den throughout the summer, for the numbers which emerge in the evening are not constant, and even on consecutive evenings, when the atmospheric conditions appear to be identical, the number sometimes varies considerably. On the other hand, it is possible that on some evenings the whole strength of the colony does not turn out, and that some of the Bats remain in the den all night."

Mr Oldham found that the time of first appearance varied from twenty-eight minutes after sunset on 21st April to seven minutes before sunset on 14th August. The hour of vespertinal emergence thus becomes progressively more diurnal as autumn approaches, until in the second week of September I have observed them to appear at about 6.30 P.M., and the October and November flights are, according to Mr Millais, all rather diurnal than vespertinal. "The Bats," writes Mr Oldham, "leave the den in rapid succession—on August 27th twenty-two emerged within a minute—but their return is much less regular. This is probably due to the varied success of individuals in obtaining food. During August and September, at any rate, on fine still evenings, the duration of the vespertinal flight is sometimes less than an hour; on August 27th a Bat entered the den fifty-five minutes, and on Sept. 4th fifty-seven minutes, after the first had emerged. On each evening, however, the flight in some cases lasted at least an hour and a half; and on Sept. 5th some of the Bats were absent for more than two hours. It is probable that on wet and windy evenings the duration of the flight is even less than an hour, but I have no data to prove this. It is easy to count the Bats as they leave their den in the twilight, but a difficult matter to make sure of the number that return. They do not often enter the hole immediately on their arrival, but dash round and among the trees, and in many cases pitch several times for an instant on the tree-trunk near the hole. Their advent is proclaimed

by the beating of their wings, but even on moonlight nights all that one sees is a form silhouetted for an instant against a patch of sky. When the Bat is flying against a background of tree-trunks or foliage, one can see nothing. It is true that a faint rustle may be heard when a Bat actually enters the hole, but this resembles the noise made when it pitches for an instant on the tree-trunk; and if two or more Bats arrive together, as often happens, the confusion is increased. A good deal of intermittent squeaking may be heard in the den after the arrival of the second Bat."

In the paper above referred to, Mr Oldham, judging from the habits and demeanour of captive specimens, expressed the opinion that the period of activity is limited to the short vespertinal flight, and that it does not again leave its den before the following evening. Mr Steele Elliott, dissenting from this view,[1] mentioned two instances of matutinal flight which happened to come under his notice; and later Mr C. B. Moffat, from the analogy of the closely allied Leisler's Bat, as well as from his own slight experience of the present species, argued[2] that there must be two flights each night. Mr Oldham subsequently undertook an all-night watch[3] outside a Noctule den in Cheshire on 20th May, with the result that the occurrence of a matutinal flight in this species may now be regarded as beyond question, although it is possible that fewer individuals are abroad at dawn than in the evening twilight. Mr Oldham found that no bat entered or left the hole after 9.36 P.M., but that there was intermittent squeaking until ten o'clock, and "a slight squeaking in the den at long intervals until 2.40 (eighty-five minutes before sunrise), when the noise increased, and more than one bat emerged—in the gloom I could not tell the exact number—and all was still until 3.20 (forty-five minutes before sunrise), when three returned. These dashed round among the branches, alighting on the trunk at the mouth of the hole once or twice, and then dashing away again before entering the den, as Noctules generally do on returning from the vespertinal flight. There was no squeaking after the Bats entered the den, and I heard none until 4.2, when I left the tree."

[1] *Zoologist*, 1901, 153. [2] *Irish Naturalist*, 1905, 105-106. [3] *Zoologist*, 1905, 307.

Occasionally the Great Bat appears in broad daylight. Mr J. W. Douglas observed[1] one mobbed by swallows, the powers of flight of which were, however, so clumsy compared with those of the bat, that it soon left its pursuers behind. Again, the Reverend A. Matthews told Mr Montagu Browne "that one broiling hot day in July . . . at midday, when the air was perfectly bright and clear, he observed swallows circling at an immense altitude, and above them, at a much higher elevation, four large bats, which he supposed to be of this species." On one occasion, writes the Reverend J. G. Tuck,[2] at about midday, a Great Bat suddenly dropped into a pond about ten yards from the bank, and swam to shore without the least difficulty. Whether the animal's swim was undertaken voluntarily or by mischance is open to question, but this species, like others, loves to touch the surface of pools of water over which it may happen to be flying.

When discovered in its diurnal retreat the Noctule will be found cold and comatose, hanging head-downwards, but tenaciously grasping the sides of the cavity with its feet. Many may be huddled together, and frequently they will make no attempt to escape, but when handled they rapidly become warm and lively. They rise quite easily from a flat surface,[3] exceptional failures being due to ill-health or overfeeding.

"The actions of the Noctules," wrote Gurney,[4] "when awaking from their diurnal sleep at the approach of evening, are curious and grotesque. They frequently open and shut their mouths for several consecutive seconds with an exceedingly rapid motion of the lower jaw; this action is succeeded by the tongue being protruded about the eighth of an inch, and the lips being thus thoroughly licked. When this is accomplished, a hearty yawn usually follows, the mouth being opened in the process to its utmost width, and the next employment undertaken is an attack on the small parasitic insects which infest the fur of these bats. The sides of the body are vigorously scratched by a rapid and continuous action of

[1] *Zoologist*, 1843, 6; see also W. S. Lewis, *Zoologist*, 1848, 2252.
[2] *Zoologist*, 1905, 231. [3] Gurney, Oldham, etc.
[4] *Zoologist*, 1874, 4194; see also *Trans. Norfolk and Norwich Naturalists Soc.*, 1869-70, 22 (published 1874).

the hind claws, and the head is bent under the body, whilst the mouth is employed in active investigation amongst the fur of the under surface. These bats when fully awake usually begin to crawl over one another, a process which generally evokes a stridulous chirping cry from the individuals which compose the lower strata of the cluster."

Although the sexes fly together, the extent of their intermingling in their places of sleep and hibernation has often formed the subject of discussion. Gurney,[1] working in Norfolk, believed that when the females have young they are found in separate colonies, which are larger than those of the males. This opinion coincides with that formed by Leisler many years before in Germany, as well as with the more recent work of Messrs R. Rollinat and E. L. Trouessart.[2] It is also supported by the recently recorded observations of Mr Booth, showing that both sexes frequented the same den in about equal numbers until the colony broke up for the summer in June and July, which is about the time that the young are usually born. It is in agreement with the known published records of the finding of both sexes together, as by Mr Harting in February, by Daniell, Mr Oldham, and Mr F. Norgate in May, and by Gurney and Mr Whitaker in September.[3] In the latter case, a small colony was found on the 2nd of the month, and on the 5th contained seven adult females and one male, which may be supposed to have resumed companionship after the young had been reared. Exceptional cases evidently occur, as when Mr Whitaker[4] met with fourteen individuals on 28th June, of which eleven were males, one a pregnant female, and one a young male aged about ten to fourteen days, and the mother of which was presumably a bat which effected its escape.

There is no evidence on one important point from British observations, but it may be presumed that, as shown to be the case in continental Europe, the true breeding season is in September, when the bats, having reared their young, are in winter quarters awaiting the period of hibernation. The commencement of gestation is, however, probably delayed until the awakening of the animals in spring.[5]

[1] *Zoologist*, 1887, 170. [2] *Supra*, p. 32. [3] *Naturalist*, 1905, 325-330.
[4] In MSS. [5] *Supra*, p. 33.

There is also some question as to a supposed preponderance of females in this genus, a matter upon which it is impossible to write definitely. Large numbers of females of the Noctule are certainly found not infrequently in their hiding-places; but on the other hand we have the contradictory experience of Mr Whitaker as related above, and that gentleman states that he and a friend had previously handled over twenty-seven Noctules taken at different times and places, without encountering a single female. In Ireland, again, Mr Moffat points out that the males of Leisler's Bat are more frequently shot than the females, so that here once more the available evidence agrees so little that more study is clearly necessary. In this connection Mr Coward's remark, as quoted by Mr Millais, that in captivity the males are more active than the females, is important, and may throw light on the relative numbers in which the two sexes are encountered in nature.

Despite its offensive smell, the Great Bat is an object of considerable beauty. Dr Henry Laver, indeed, contrasting its rich brown fur, smoother and finer than velvet, with its dusky wings, pronounces it to be the most beautiful of its order. Although on the wing for so short a time, it is generally sleek and plump, especially in autumn,[1] when it accumulates much fat both internally and as a thick layer under the skin, leading, according to Mr Aplin, to a noticeable increase of weight as compared with that of early summer.

All writers agree that,[2] at least when new to captivity, the Noctule, especially the male, displays much irritability, restlessly biting the bars of its prison, its fellow-captives, and its capturer, but confinement does not seem to interfere with its health, since it may easily be kept alive for a period of some weeks.

The first published account of this species when in captivity, was that of George Daniell, who ascertained many interesting particulars concerning its lactation and parturition, and embodied them in a very pleasing essay.[3]

[1] Gilbert White; W. Borrer, *Zoologist*, 1874, 4125; Aplin, *Zoologist*, 1885, 344; Dowker, *Zoologist*, 1891, 305.

[2] F. R. Rodd, *Zoologist*, 1891, 347; Oldham, etc.

[3] *Proc. Zool. Soc.* (London), 1834, 129-132.



1



2



3

HEADS (natural size) OF

1. *Nyctalus noctula.* 2. *Nyctalus leisleri.*
3. *Vespertilio serotinus.*

Daniell's observations show that he had observed, although not with complete understanding, the use of the interfemoral membrane by bats as a pouch wherein to secure their prey, and he particularly noticed that, unlike the Pipistrelle, his captive Noctule made no use of this contrivance.

In feeding, he wrote, "the wings were not thrown forward as in the Pipistrelle; and the food was seized with an action similar to that of a dog. The water that drained from the food was lapped, but the head was not raised in drinking, as . . . observed . . . in the Pipistrelle. The animal took considerable pains in cleaning herself, using the posterior extremities as a comb, parting the hair on either side from head to tail, and forming a straight line along the middle of the back. The membrane of the wings was cleaned by forcing the nose through the folds, and thereby expanding them. Up to the 20th of June the animal fed freely, and at times voraciously, remaining during the day suspended by the posterior extremities at the top of the cage, and coming down in the evening to its food: the quantity eaten sometimes exceeded half an ounce, although the weight of the animal itself was no more than ten drachms," an observation which agrees very closely with those of Mr Whitaker,[1] who possessed a Noctule which on one occasion actually devoured the enormous number of eight dozen mealworms at a sitting, and which consumed an average of about seven dozen, weighing in all about a quarter of an ounce daily, or about a quarter of its own weight.

Of four females which came into Daniell's hands on the 16th of May, each was pregnant with a single fœtus, but only one survived to bring it to a natural birth. Of this one it is related that on 23rd June, after exhibiting much restlessness for upwards of an hour, she suddenly reversed her usual attitude of suspension by the posterior extremities, and attaching herself by her anterior limbs to a cross-wire of the cage, gave birth to a young one. This, being born on its back, passed into the interfemoral membrane, which was expanded so as to form a perfect nest-like cavity for its

[1] *Naturalist*, 1905, 325-330.

reception. The young bat was at its birth perfectly destitute of hair, and blind. As soon as it was born, the mother "licked it clean, turning it over in its nest, and afterwards resuming her usual position, and placing the young one in the membrane of her wing, proceeded to gnaw off the umbilical cord and eat the *placenta*. She next cleaned herself, and wrapped up the young so closely as to prevent any observation of the process of suckling. The time occupied in the birth was seventeen minutes. At the time of its birth the young was larger than a new-born mouse, and its hind legs and claws were remarkably strong and serviceable, enabling it not only to cling to its dam, but also to the deal sides of the cage. On the 24th the animal took her food in the morning, and appeared very careful of her young, shifting it occasionally from side to side to suckle it, and folding it in the membranes of the tail and wings. On these occasions her usual position was reversed. In the evening she was found dead; but the young was still alive, and attached to the nipple, from which it was with some difficulty removed. It took milk from a sponge, was kept carefully wrapped up in flannel, and survived eight days, at the end of which period its eyes were not opened and it had acquired very little hair."

Daniell's remarks are in part borne out, in part opposed, by those of Mr Whitaker,[1] who has added not a little to our knowledge of young Noctules. In Mr Whitaker's case a female gave birth to her single young one on 30th June. Her attitude was the normal one, with the head downwards. "As soon as ever the head of the baby Bat protruded it commenced to squeak lustily. The young was quite free in about four minutes' time, and worked its way under the shoulder of its mother, and so round on to her back, where it clung quite exposed, head downwards. . . . The note of the young Noctule is a single chirrup even more highly pitched than the note of the adult. It is so penetrating that when but a few days old I could hear the young Bat calling after I had gone to bed at night, though it was in a cage downstairs, and in a room not directly under my bedroom." For some time the mother appeared disinclined to recognise her offspring, but at

[1] *Naturalist*, 1905, 325-330.

length on the third day, after she had been induced to eat and was no longer hungry, it was accepted. "She first seized it quite roughly in her mouth, and taking no notice of its vigorous squeaking and struggling, proceeded to give it a good wash and brush, much after the style of a Cat washing its kitten. She then tucked it away under the skin between the shoulder and thigh, pushing it so far round that it appeared only as a protuberance on her back. This I found later was the invariable method of carrying the young one, who was packed away like this, head downwards, all along, and suckled from this position by merely stretching its neck a little. For the first week my Noctule always kept the young one tucked under her right wing, as far as I saw, and I believe it suckled from that side only. Later it put it under either wing indifferently."

The young bat was quite capable of hanging by itself in its cage, but sometimes the mother carried it with her, "in which case the young one clung to her with its teeth and was dragged along under her, trying to walk, with its hind feet projecting from under its mother and close to hers, so that she seemed to have four back feet, all working out of time. The effect was decidedly comical. In spite of this, the 'baby' did not seem to hamper its mother's movements very much when she was crawling. When disengaged from its mother the young one would cling with extraordinary tenacity to the gauze sides of its cage, or to a handkerchief on which we once or twice photographed it, and great care was necessary to remove it without injury from anything of which it had got a firm hold."

When on one occasion allowed to fly with her young one, the mother "hesitated a long while before making the attempt, and when she did so only flew the length of the room, and then dropped rather heavily upon the floor, the young one remaining under her right wing all the time."

After eleven days the young one, captivity having probably delayed its development, was still blind and naked, and unfortunately on the night of that day, the mother having escaped, it disappeared under circumstances suggesting that she herself came back to the cage and stole it away.

According to British observations, the period of gestation

exceeds thirty-eight days. To these should probably be added another eleven,[1] so as to complete the seven weeks laid down by continental naturalists, but corroboration is still needed for this country. The most usual time for the birth of the young is evidently late in June. Thus Mr H. J. Charbonnier found within the body of a female killed in June a young one having an expanse of wing of $3\frac{1}{2}$ inches, and Mr Oxley Grabham[2] writes me that he has received one, a dark, leathery-looking object, just beginning to show indications of fur (and therefore at least fourteen days old), on 16th July. Gurney informed Newman[3] that he once disturbed a colony of females, many of which had half-grown young ones with them, and he observed that when the mothers flew away, the young ones clung to their under sides, and seemed to be carried without the slightest inconvenience to mother or young. On the other hand, Mr Whitaker took a ten days' old youngster from a hole in a tree, where it remained after the departure of the adult members of the colony, including its mother, so that it is evident that the young may either accompany their parents when flying, or, when they have grown inconveniently heavy, may remain suspended in the den (Plate III., p. 58). Whatever else be the case, it is evident that the young must grow so rapidly as to shift for themselves at an early date, and thus relieve their mothers from burdens so tiresome. The increased numbers which have been noticed in August, as by Mr Jeffrey writing to Newman,[4] may probably have represented the influx of the newly-fledged young, and Noctules exhibit marked disagreement in size at this season.

Although there is only one published instance for Britain of the production of more than a single young one at a birth,[5] the statements of continental writers[6] are quite clear that families of two have frequently come within their experience, a remarkable instance of fertility, varying with locality, which is discussed elsewhere (p. 37).

[1] *I.e.*, the true period from ovulation followed by fertilisation (not from copulation) to parturition.

[2] *Naturalist*, March 1899, 71. [3] *Field*, 7th March 1874, 218. [4] *Ibid.*

[5] L. Jenyns, *Observations on Natural History, etc.* (London: Van Voorst), 1846, 56.

[6] As by Carl Vogt, who examined twelve females, in five of which were two, and in six only one embryo (see *supra*, p. 31).

The Great Bat has frequently been kept alive since Daniell's time. Mr Oldham's description of its habits while in confinement is the most detailed, and may be quoted at length :[1] — Like other bats in captivity, it "shows little inclination for flight, especially in an artificially lighted room, and when it does take wing, frequently collides with the walls and furniture. A confined space is indeed unsuited to its bold and dashing flight, although in a darkened room it will remain on the wing for some time and avoid accidents. In walking—a captive Bat's usual mode of progression—the body is carried clear of the ground, and supported on the feet and wrists only. The tail is curved downwards and forwards, and the inter-femoral membrane pressed against the belly. The fore limb is spread considerably, but the phalanges with their connecting wing-membranes are tightly closed and folded back along the lower arm. In ascending a curtain or picture-frame, the claws on the thumbs are brought into use, and the tail, instead of being curved beneath the body, is then extended backwards, with the tip pressed closely against the surface of the object up which the Bat is climbing. For the time being, it is analogous to the stiffened rectrices of a Woodpecker or Tree-Creeper.

"Any instinctive dread which Bats may have of man disappears quickly in captivity, but the Noctule is exceptionally fearless. Within a few minutes of their capture, I took two of the Bats singly from among their struggling fellows in the bag, and, holding them in one hand, offered mealworms with the other. So cramped were they that they could not move their limbs, but they seized and devoured the insects with the utmost *sang-froid*. On the same evening others were climbing about my arms and neck without any signs of fear; and the old female which I had for several weeks used habitually to clamber up my arm as it rested on the table, and snuggle against my neck."

The captives drank freely. "Their food consisted of mealworms . . . , raw lean beef, and such moths, beetles and other insects as I was able to procure. All food was thoroughly masticated by an extremely rapid movement of the jaws before it was swallowed. The wings of moths were generally consumed, but the horny elytra of large beetles were bitten off and

[1] *Zoologist*, 1901, 51-59.

allowed to fall as the insect disappeared in the Bat's mouth. Mealworms and small moths, as well as . . . " beetles of lesser size, were seized and eaten without any attempt to overcome their struggles. On the other hand, large moths were sometimes, and powerful beetles always, thrust by the bat into the pouch formed by the interfemoral membrane, in order to secure them effectually before they were eaten. A cricket offered to one of Mr Coward's bats was treated in the same way, but cockroaches were in some instances thrust into the pouch, and at other times eaten without that preliminary. It should be remarked, however, that cockroaches, despite their size, submitted very tamely to their fate. On no occasion was foot, carpus, or thumb used to secure or dismember prey.[1]

Mr Oldham's bats seemed unable to see food if held but little more than an inch in front of them, and this was the case in natural twilight as well as in an artificially lighted room. He, therefore, thinks it very doubtful whether in a free state they would avoid a distasteful moth, because its nauseous properties happened to be advertised by warning colour, but Mr Forrest remarks[2] that this does not prove that the Noctule may not be "far-sighted, and see an insect in the air at a distance of several feet better than close at hand on the table." It is, however, interesting to note that no amount of persuasion would induce the bats to eat notoriously unpalatable insects.[3] These, although repeatedly offered, were invariably rejected with disgust, as was an oil beetle in a similar experiment tried by Mr Coward. Two other moths[4] also appeared to be unpalatable, but in a lesser degree.

This bat is one of the largest of the species frequenting Britain. Two others alone, the Serotine and the Greater Horseshoe, are in this respect its equal, or occasionally its superior: their flight is, however, distinct, and their

[1] The following, among other species of moths, were readily eaten by Mr Oldham's bats while in captivity:—*Mamestra persicariæ*, *Leucania pallens*, *Hepialis humuli*, *H. sylvinus*, *H. hectus*, *Rumia cratægata*, *Urapteryx sambucata*, *Odontopera bidentata*, *Fidonia atomaria*, *F. piniaria*, *Xylophasia polyodon*, and *Amphidasis betularia;* the list may be completed by the Poplar Hawk Moth, *Smerinthus populi*, with one of which species Whitaker fed his captive Noctule (*Naturalist*, 1905, 325-330).

[2] *Trans. Caradoc and Severn Valley Field Club*, 1900 (Feb. 1901), 244.

[3] As *Euchelia jacobææ* or *Abraxas grossulariata*.

[4] *Spilosoma menthastri* and *S. lubricipeda*.

peculiarities will be pointed out in the proper place. With these exceptions it could be confused only with the much smaller Leisler's Bat. Unlike some other species, the Noctule flies with the tail directed straight backwards, or with only a very slight downward curve, a fact which may be supposed to have some connection with the less frequent use of the interfemoral pouch than in smaller and less powerful species.

LEISLER'S BAT.

NYCTALUS LEISLERI (Kuhl).

1810. DIE RAUHFLÜGLICHE FLEDERMAUS, T. P. Leisler, *Magazin für die Neuesten Entdeckungen in der Gesammten Naturkunde* (Berlin), 156; described from Hanau, Germany.

1819. VESPERTILIO LEISLERI, Heinrich Kuhl, *Ann. der Wetterauische Gesellschaft für die gesammte Naturkunde*, iv., 46, naming Leisler's *Rauhflügliche fledermaus*; Jenyns; Bell (ed. 1); Clermont; Newman.

1819. VESPERTILIO DASYKARPOS LEISL. (*sic*), Heinrich Kuhl, *op. cit.*, 49, quoting Leisler's unpublished MSS.

1829. PTERYGISTES LEISLERI, Jakob Kaup, *System der Europäischen Thierwelt*, i., 100; C. B. Moffat (doubtfully), *Irish Naturalist*, 1905, 104; Miller; Thomas; Johnston; Méhely; Cabrera; Millais, 8 and 76.

1838. SCOTOPHILUS LEISLERI, J. E. Gray, *Mag. Zool. and Bot.*, 497; MacGillivray; Bell (ed. 2).

[? 1839. VESPERTILIO PACHYGNATHUS MICHAHELLES (*sic*), J. A. Wagner's ed. of J. C. D. von Schreber's *Die Säugthiere*, Supplement i., pl. lv. *b*. There is no description, but Fitzinger states that Michahelles found this bat in Dalmatia: it appears to be a small *Nyctalus*.]

1839. VESPERUGO LEISLERI, A. Graf von Keyserling and J. H. Blasius, Wiegmann's *Archiv für Naturgeschichte*, i., 318; Blasius; Fatio; Dobson; Blanford; Alcock; Moffat.

1856. PANUGO LEISLERI, F. A. Kolenati, *Allgemeine deutsche Naturhist. Zeitung* (Dresden), Neue Folge, ii., 131, 172.

1870. NOCTULINIA LEISLERI, L. J. Fitzinger, *Sitzungsberichte der Kaiserlichen Akad. der Wissenschaften* (Vienna), lxii. (1), 218; Harrison Allen, *Proc. U.S. National Museum*, xvi., 30, footnote, 1893.

1898. PIPISTRELLUS LEISLERI, Oldfield Thomas, *Zoologist*, 100.

Le Vespérien de Leisler of the French (Fatio), *die rauharmige Fledermaus* of the Germans (Blasius); but these are merely book-names, as is the Hairy-armed Bat of Bell and others, there being no **local names** for such a little-known species.

Distribution:—Leisler's Bat, or species closely resembling it, is found in the wooded districts of boreal and transitional Europe and Asia, from sea-level to 4500 feet (Fatio) in the Alps, from middle Russia to Greece

(Winge), and probably the shores of the Mediterranean generally, and from Ireland probably to China. As in the case of *N. noctula*, the exact limits of its range are very imperfectly known, but allied forms (mentioned on page 54) are known from the Azores, Madeira, the Himalayas, and the Oriental Region.

The distribution of Leisler's Bat is still very imperfectly known for **Great Britain**, where it ranks as one of the rarest species. Its admission to the British list rested for many years upon the slender evidence of a single historical specimen in the British Museum, figured by Bell in both his editions.

To this record Tomes, before 1874, added a specimen in the Bond collection, taken near Cirencester. Tomes himself not unfrequently observed the species along the course of the river Avon, in the counties of Warwick, Worcester, and Gloucester, and therefore concluded that it must be less rare than had hitherto been supposed.

More recent study has added a few county records. Thus, for Yorkshire, Bond informed Newman (*Field*, 7th March 1874, 218) that he had seen specimens taken from a chimney-shaft near Leeds: Clarke and Roebuck give the date of these as about 1840, and the exact locality as Hunslet (see Grabham, *Naturalist*, 1899, 72); one of these was in Bond's collection, and at his death passed into the possession of Harting. Charbonnier obtained seven shot at Mexborough in 1890, one of which is now in the British Museum (*Zoologist*, 1892, 329); lastly, Armitage and Whitaker have found the species not uncommon near Barnsley and Wakefield (Coward, *Zoologist*, 1905, 68; Armitage, *Naturalist*, 1905, 37-38, and Whitaker, 1907, 384-388, and 416-418).

In Cheshire, Coward shot one in Dunham Park in 1899 (*Zoologist*, 1899, 266). He has occasionally observed the species since, and believes that it is more abundant than is generally supposed.

There is an old and doubtful record for Norfolk: T. Paine, jun. (*Ann. and Mag. Nat. Hist.*, Nov. 1838, 181-183, published 1839), identified as referable to this species fourteen bats taken from a hollow tree near Norwich. Jenyns, who examined one of them, declared (*Journ. cit.*, 481) that it was "not a specimen of *V. leisleri*," but was undecided whether it was "the young of a Noctule or a distinct species." Apparently no skull was submitted to Jenyns, but the description and dimensions given by Paine agree so well with those of *N. noctula* that I have no hesitation in connecting his specimens with that species. Possibly the band of hair on the arm, which occurs in *N. noctula* as well as in *N. leisleri*, misled both Paine and Jenyns.

The bat is thus known to occur only in three isolated districts—the West Riding of Yorkshire, Cheshire, and the valley of the Avon—in Great Britain; judging, however, from its abundance and extended distribution in Ireland, there seems to be no apparent reason why it



1 2

Nyctalus leisleri, adult (1), and *N. noctula* (2), recently born, to show the relative difference in size, especially of foot and thumb.

PLATE V.



1

2

3

WINGS (½ natural size) OF

1. *Nyctalus leisleri.* 2. *Pipistrellus pipistrellus.*
3. *Myotis daubentoni.*

should not occur in other parts of **England, Wales,** and even in **Man** and **Scotland** (see Service's observations under *N. noctula*).

This bat is well known in **Ireland,** where the first recorded was taken in Belvoir Park, Co. Down, about 1848. A second was knocked down by a mechanic with a fishing-rod in Blackstaff Lane, Belfast, Co. Antrim, in July 1858. It passed into the hands of Darragh, and was exhibited by J. R. Kinahan at a meeting of the Belfast Natural History and Philosophical Society on 25th April 1860.[1] In 1868 the species was found abundantly in Armagh by Barrington, who also received a specimen from Kildare (*Zoologist*, 1874, 4071-74), and it has since been discovered in Dublin (Ogilby, *Journ. cit.*, 1874, 4236), Wicklow (Barrington, *Journ. cit.*, 1875, 4532), Fermanagh (Barrington, *Journ. cit.*, 1883, 116), Westmeath (Moffat, *Irish Naturalist*, 1897, 135), Cavan, Louth (Jameson, *Journ. cit.*, 1897, 41-42), Londonderry (Alcock, *Journ. cit.*, 1899, 174), Carlow and Wexford (Barrett-Hamilton, *Journ. cit.*, 1900, 134; Moffat, 162; Pack Beresford, 1906, 194). Its range, although a few county records, *e.g.*, for Kilkenny, Meath, and Monaghan, are needed for continuity, may be said to include the whole east coast, together with a considerable portion of the north and north-west. In many districts it is common, or even abundant, and, although no western or south-western specimens are forthcoming, R. E. Dillon (in lit., also quoted by Jameson) is well acquainted with large, straight-flying bats, almost certainly of this species, at Clonbrock, Co. Galway, and Laver informs me that he has seen many in the same county; one, labelled Tyrone, is in the Dublin Museum. It is probable, therefore, that the bat has been overlooked in many parts of Ireland.

Distribution in time:—This bat is not known as a fossil.

Period of gestation:—Although no observations have been published, there is no reason to suppose that this differs from that of the Noctule.

The number of young, although stated to be usually two in Germany, is not known to exceed one in Britain (see Tomes, *Zoologist*, 1854, 4365), born early in summer, probably in June.

Description:—This bat resembles the Noctule, but is much smaller. The body is relatively lighter, and the bones of the limbs less massive and of somewhat different proportions.

Thus in the **wing** (again as compared with the Noctule) (Plate VII., Fig. 1), while the greatest expanse, third metacarpal and longest digit are relatively of smaller dimensions as compared with their forearm, the lower leg is markedly, the tail and fifth metacarpal slightly, longer, so that the wing and interfemoral membrane are slightly shorter and distinctly broader.

[1] The first published proceedings of the B. N. H. and P. Society date from 1871, but Robert Patterson has most kindly looked up the present reference for me in the old minute-books.

The **foot** is comparatively feeble, the post-calcarial lobe less conspicuous, and its outer margin not thickened (Plate V., p. 64).

There are two phases of **colour.** In the one represented by an Irish female, dated 8th September, the fur is so dark—between "olive," "bistre," and "sepia"—as almost to reach "clove brown," the hair-tips lighter; in the other, represented most frequently by males in spring and early summer, the hairs have a conspicuous rusty tip of almost a third of their length, giving the bat a much more *noctula*-like appearance: in this phase specimens vary between an intensified "wood brown" and some shade of "mars brown." The two phases are not distinctly marked off, and may intergrade; in both, the under side is lighter. The membranes, limbs, and ears are dusky, as in *N. noctula.*

Dr Alcock states that he sometimes, but not always, found Irish males to be darker than their females, and the same remark is said to apply to the young.

Nothing is known of the processes of **moult**, or of a seasonal colour change, but a series of fourteen examples (seven of either sex) of the allied *N. azoreum* of the Azores suggests that the rusty phase may represent the fading of the old winter coat in spring, and the dark phase its replacement by a new pelage—a process which, as in many other mammals, is characterised by much irregularity. The Azorean specimens were obtained by Ogilvie-Grant and N. C. Rothschild between 8th March and 17th May. The females are in fully tinted pelage, but the males, except one, are much faded, as if in very old coat; the exception, killed on 17th May, appears to be in process of acquiring the new pelage, perhaps already donned by the females. Similarly, a Roumanian male of 22nd April is in rusty faded pelage.

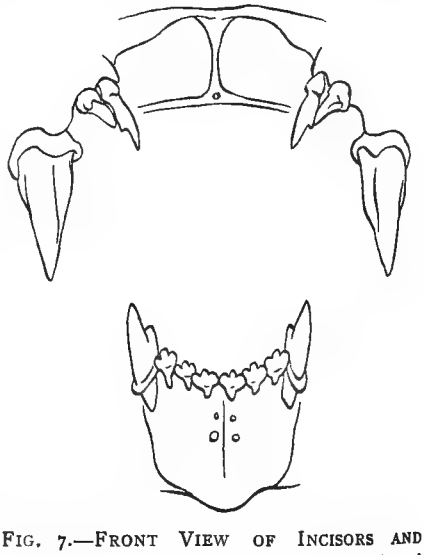


FIG. 7.—FRONT VIEW OF INCISORS AND CANINES OF *Nyctalus leisleri* (enlarged and diagrammatic).

The **skull** is less than half the size of that of *N. noctula*, its structure is weaker and more papery, and the crests, especially the sagittal, are absent or feebly developed (Fig. 16, No. 1, p. 174).

The **teeth** are similar, but much smaller. The outer upper incisor is comparatively small, its cross-section at the base being about equal to, *not* about *double*, that of the inner incisor. The anterior upper

premolar is relatively larger, and the *lower incisors*, being smaller, are less crowded and *do not usually overlap* (Figs. 7, p. 86, and 16, No. 1, p. 174).

No material exists upon which to base any account of either the **individual** or **exceptional variation** of this species, but Moffat informs me that there are two melanic examples in the Dublin Museum.

Geographical variation, as in *N. noctula*, shows itself mainly in regard to size and cranial characters, especially in the relative development of the crests (for particulars, see above, p. 54). I have carefully compared the Irish and English specimens in the British Museum, but cannot distinguish them.

DIMENSIONS IN MILLIMETRES:—

	Head and body.	Ear, greatest length.	Tragus, greatest length.	Tail.	Lower leg.	Hind foot, without claws.	Forearm.	Thumb and claw.	Longest digit.	Metacarpal III.	Metacarpal V.	Greatest expanse of wings.
Leach's specimen in British Museum (No. d. 63A)	..	..	..	..	..	..	43	..	..	..	..	..
Male, Mexboro', Yorks. (H. J. Charbonnier, No. 90. 7. 6. 1. of British Museum collection)	..	..	..	..		..	43	..	..	..		..
Male (in alcohol), Bray, Ireland (R. M. Barrington per J. E. Harting, No. 90. 2. 14. 1. of British Museum collection)	56	.	..	..	19	9	42		..	38	32·5	..
Male, Co. Clare, Ireland (Dublin Museum)	..	..	..	..	16·5	7	42	..	..	40·2	32	..
Male, Co. Dublin, Ireland (Dublin Museum)	..	..	..	..	17	8	42·5	..	..	40	31	..
Male, Co. Louth, Ireland (Dublin Museum)	..	..	..	.	16	8	40	..	..	37	30·5	..
Female (in alcohol), Armagh, Ireland (R. M. Barrington)	57·5	14·5	6	..	18	7·5	42	6	71	36	30	.
Female, Co. Armagh, Ireland (R. M. Barrington per G. E. Dobson, No. 89. 11. 12. 5. of British Museum collection; labelled "var. *hibernicus*" in Dobson's handwriting	61	14	4	..	19	9	44	..	74	39	33	
Female, Belfast, Ireland (R. Patterson per G. E. H. Barrett-Hamilton, No. 01. 3. 15. 1. of British Museum collection)	62·5	17	4	41	..	..	43	..	..	..		*295 (approx.)
Female, Co. Dublin, Ireland (Dublin Museum)	..	..	..	..	18	8	44·5	..	..	39	33	..
Female, Co. Dublin, Ireland (Dublin Museum)	..	..	..	..	17	8	43	..	..	39·5	31	
Male, immature, Co. Cavan, Ireland (Dublin Museum, in alcohol)	..	.	..	..	15·5	8	39	..	62 (approx.)	35	28	
Male, immature, Co. Dublin, Ireland (Dublin Museum, in alcohol)	..	..	..	..	15	7·5	38·5	..	.	34	29	..
Average of adults (approximate)	59·5	15	4·5	..	17	8	42	..	72·5	38·5	31·5	..

* 11⅝ inches in the flesh, *fide* R. Patterson, corroborated independently by Whitaker, who gives the average wing-expanse of six Yorkshire females as 304 (*Naturalist*, 1907, 386).

For the following table of measurements I am indebted to Charbonnier. They were printed on page 65 of Lloyd Morgan's *Animal Life and Intelligence* (London), 1890-1891 :—

	Forearm.	Thumb.	Digit II.	Digit III.			Digit IV.			Digit V.			Lower leg.
			Metacarpal.	Metacarpal.	Phalanx 1.	Phalanges 2 and 3.	Metacarpal.	Phalanx 1.	Phalanges 2 and 3.	Metacarpal.	Phalanx 1.	Phalanges 2 and 3.	
Males .	41	6·5	38	40	16	19	38	14	7	32	8	7	16
	41	6	38	40	16	19	39	15·5	7	33	8	6·5	16
	41	6	39	40	16	18	39	16	6·5	33	8	7	16
	41·5	5	39	40·5	17	20	39	16	7	33	8	7	15
Females .	40	6	39	37	15·5	18	37	14·5	7	32	8	6·5	15
	41	5·5	38·5	39	16·5	20	39	15	7·5	33	8	7·5	17
	41	6	39	40	15·5	20·5	39	15·5	7	33	8	7	16
Average of 7 .	40·9	5·7	38·6	39·5	16	19·2	38·5	15·2	7	32·7	8	6·9	15·8

Proportionate lengths:—Foot (without claws), about ·45 of lower leg; fifth metacarpal, about ·82 of third; lower leg, about ·41 of forearm, and about ·29 of head and body.

Skull:—Greatest length, 15; basal length in middle line, 11·25 to 12; palatal length in middle line, 5·5 to 6; from posterior border of m^3 to anterior border of canine, 6·5 to 6; ditto in lower jaw, 6 to 6·5; greatest breadth at zygoma, 10 to 10·5; posterior breadth, 9; breadth between orbits, 8; breadth at constriction, 5 (nearly).

Weight:—14 to 20 grammes (Moffat, *Irish Naturalist*, 1900, 235).

Distinguishing characters:—Lack of familiarity with this bat has led most naturalists to regard its identification as difficult, and even to confuse it with *N. noctula*. The two, however, when closely compared are remarkably different, and, apart from the distinctions based upon dimensions, colour, and odour, the relative proportions of the wing, lower leg, and foot, are infallibly diagnostic (Plate V., p. 64). The only other British species which bears any resemblance to Leisler's Bat is the Pipistrelle, but here again there is no need to search farther than the length of the forearm for points of distinction.

The bat on which Bell, following Leisler, bestowed the not very satisfactory name of Hairy-armed, was first discovered by the latter naturalist in Germany, and described by Kuhl in 1819; it has ever since remained one of the least known of English bats. It made its first appearance as a

British mammal in the first edition of Bell, whose figure, taken from a single specimen in the British Museum, was the first representation of the species.

We are now familiar with the appearance and habits of this, at least in Ireland, locally abundant species. In England, however, its distribution is still very imperfectly known, but its general reputation for rarity, judging from the late R. F. Tomes's observation of it at various localities in the valley of the Avon, is probably exaggerated.

Inability to distinguish it from the Noctule—of which, in all external characters, except colour and odour, and in many of its habits, it has long been considered a duplicate in miniature — and the very short period of the day during which it may be observed upon the wing, have probably contributed to neglect of this bat by English naturalists; whereas by the Irish, who are not troubled with the confusion created by the presence of the Noctule, it is more easily identified and brought under observation. As a matter of fact, the two are so distinct when in the hand, and the shape and proportions of their wings are so different, that it is likely that, now that these characters have been published, closer study will reveal corresponding divergences in habits, and lead to means of identification on the wing.

Until the year 1899, there existed no published account of the habits of this species in English other than the few lines inserted by Tomes in Bell's second edition. "Previously to 1849," wrote Tomes, "a Bat had often been observed which, from its smaller size and different mode of flight, appeared to be quite distinct from the Noctule; but it was not until June of that year that an opportunity occurred of examining a specimen; the difficulty of obtaining specimens arising not so much from its rarity as from its general habit and style of flying. Whilst the Noctule may throughout the whole of the summer be seen taking its regular evening flight, night after night, near the same spot, the Leisler's Bat, on the contrary, will be seen once, perhaps for a few minutes only, and then lost sight of. It appears to affect no particular altitude in its flight any more than it preserves a regular or prescribed beat. When the weather is fine, you may see this bat passing on in

a kind of zigzag manner, apparently uncertain where to go, generally, though not always, at a considerable elevation, and in a few minutes it is gone."

Such was the meagre sum total of our knowledge, until in June 1868 Mr R. M. Barrington happened upon a large colony in the beech woods at Tandragee, County Armagh, Ireland.[1] Thence he procured specimens in 1874 and again in 1889, in spite of which the bat remained for many years immersed in an obscurity which was at length only dispelled by the labours of Mr H. Lyster Jameson[2] on its distribution, and by the excellent original observations on its habits by Dr N. H. Alcock[3] and Mr C. B. Moffat.[4] The latter was probably the first British naturalist to undertake a series of all-night watches in the haunts of the bats, thus proving beyond question the existence of two short flights, the one vespertinal, the other matutinal, in this species, exactly as Mr Charles Oldham has since shown to be also the case with the Noctule.

Like the Noctule, Leisler's Bat is usually an inhabitant of woods,[5] where it frequents, often in large parties, the cavities of hollow trees, communicating to them an odour which, however, is much less perceptible than that of its congener. Its numbers evidently rival those of the Noctule, since Mr Barrington estimated the strength of one band at from eighty to a hundred, the combined squeaking being sufficient to cause their discovery. In addition to trees, it retires also to the roofs and recesses of buildings or walls. Mr Barrington[6] found great numbers in the roof of a boat-house in County Fermanagh; Mr P. W. Finn sent me one taken from a hole in a barn in Carlow, while a party for some time occupied a hole in the stable wall at Kilmanock, County Wexford.[7] Extreme darkness would not appear to be a necessity for its comfort, since the colony discovered at Tandragee were in full view from without, and Mr Finn's specimen was discovered

[1] *Zoologist*, 1874, 4071-4074.
[2] *Irish Naturalist*, 1897, 41.
[3] *Ibid.*, 1899, 169-174, and map.
[4] *Ibid.*, 1900, 235-240; 1905, 99-101.
[5] Arthur Whitaker found a den in Yorkshire, in an oak at a height of about forty feet from the ground, which elevation he states to be greater than any Noctule den known to him (*Naturalist*, 1907, 385). If it should prove that this bat has a preference for inaccessible retreats, its reputed rarity might thus be to some extent explained.
[6] *Zoologist*, 1883, 116.
[7] *Irish Naturalist*, 1900, 134.

while asleep in the sun at the edge of its abode. Mr Moffat also informs me that he knew of one which slept in a hole in a birch-tree, in a situation where the morning sun shone full on its face.

Although fond of congregating in colonies, solitary individuals are frequently to be found. Mr Moffat has met with them from the middle of May to the end of September, and he suggests that our information concerning the number leading a gregarious life may be quite misleading, since it is the largest and noisiest assemblages that are the most easily discovered.

This bat would appear to fly for a shorter period of summer than any other known British species. In the County Dublin it does not usually appear on the wing until about 20th April, but by the end of that month it may be seen in numbers, so that it is probable that the hardier individuals may appear earlier in the month. It hibernates early, retiring abruptly on or about 26th September, a date arrived at independently by Dr Alcock at Dublin and by Mr Moffat in Wexford. The abruptness of its disappearance is remarkable; thus, in 1899, at Ballyhyland, County Wexford, Mr Moffat made the following observations, as quoted from his journal: "September 25th, usual number flying; 26th, only one; 27th, none"; the maximum temperature for the three dates being respectively 57½°, 53°, and 49° Fahrenheit.

Although hibernation commences early, it is liable, as in the case of the Noctule, to interruptions dependent on the state of the weather. Mr Finn's specimen was taken on 21st October, and had been flying with regularity for the previous fortnight, sallying forth "every evening to the minute at the same time." Mr Moffat has seen many on the wing in Wicklow on 17th, and a single individual on 20th October, and the late A. G. More identified one captured in a bedroom on 16th November.[1] Mr Moffat writes: "The lowest temperature at which I have noted Hairy-armed Bats in the open is 46° (on October 8th, 1899), but on that evening they were out in some numbers. I therefore think that this species is more influenced by the heat of the *day* than by that of the actual

[1] Moffat, *Irish Naturalist*, 1897, 135.

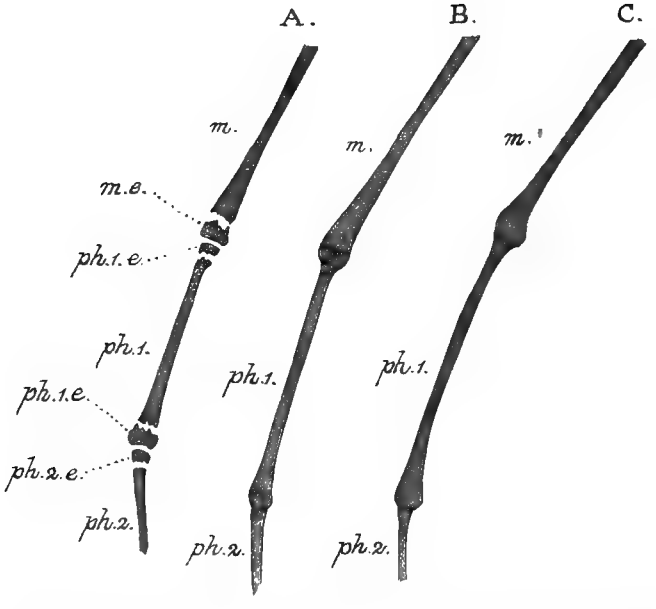
time of flight; for I have never seen it when the day's *maximum* was below 52½°, and never *numerously* with a lower maximum than 56° Fahr."

In 1899 Dr Alcock[1] stated his belief that the activity of Leisler's Bat is probably restricted to a single hour's flight each evening, commencing about fifteen minutes after sunset, ten minutes earlier in spring, and ten minutes later in autumn. The history of the discovery of the exact limits of this vespertinal, together with the existence of a matutinal flight as well, is so peculiarly Mr Moffat's own, that I feel that I should be doing him an injustice did I not quote his description at full length.

"For a mammal to enjoy so short a period of daily activity as this one hour," wrote Mr Moffat in 1900, "would be very singular, and during a recent visit to Fassaroe [Co. Wicklow] . . . I obtained evidence that the flight is not so strictly limited, for on July 22nd I saw several bats of this species flying in the *early morning*:—the first and last being noted respectively at 2.56 and 3.36 A.M., or 65 and 25 minutes before sunrise. That they were Hairy-armed Bats I was certain; but specimens could not then be procured."

However, the discovery that Leisler's Bat "is a morning flier was a useful step towards tracing some of these animals to their sleeping-place at Ballyhyland, the morning light being infinitely preferable to that of evening for such a purpose. On the morning of August 10th I accordingly watched from 2.45 A.M. in the pasture-field already referred to, taking my stand near an old and hollow ash-tree which I had reason to suspect the bats might inhabit. At 3.35 A.M. their screams were audible in the open, where several were soon afterwards seen, hawking and sporting above the level of the tree-tops. At 4.2 one of them suddenly dipped from its elevation, and when near the ground darted towards the trunk of the old ash, where it entered a hole about seven feet from the ground. At 4.5 another dipped, and shot into the same hole. At 4.11 a third followed suit; at 4.12 a fourth entered another hole, some two feet higher up in the same tree. This was the last bat seen that morning. The four individuals noted

[1] *Irish Naturalist*, 1899, 169-174, and map.



PORTIONS OF FINGER SKELETONS OF BATS (diagrammatic), ENLARGED TO SHOW STAGES IN OSSIFICATION OF THE JOINTS.

m, Metacarpal; *ph* 1, phalanx 1; *ph* 2, phalanx 2; *me*, metacarpal epiphysis; *ph* 1 *e*, first phalangeal epiphysis; *ph* 2 *e*, second phalangeal epiphysis.

A. Young specimen with epiphyses quite distinct from phalanges and metacarpal.

B. Older but still immature specimen, in which ossification, although advanced, is incomplete, and the outline of all the bones composing each joint is visible.

C. Fully mature specimen, in which all trace of the epiphyses has been lost.

had homed respectively 33, 30, 24, and 23 minutes before sunrise.[1]

"The hole into which three of the four bats had vanished was evidently the entrance to a cavity of some extent, but it was too narrow to admit of any examination of the interior. In the evening I saw the three come out again, one at 7.53 and two at 8 P.M., or 16 and 23 minutes after sunset. On the following evening five were seen, all issuing from the same hole, between 7.47 and 7.57—their times of emergence being respectively 12, 16, 17, 19, and 22 minutes after sunset. On the 12th I again saw five come out: the first *one* minute, the others respectively 8, 11, 13, and 16 minutes after sunset. When quitting their abode, though high fliers at other times, these Bats skim very low over the grass.

"The question of the animal's return to its sleeping-den during the night was less easily settled. On two evenings I watched the hole without any success, though the moon was full and bright, and I hid in the shadow of the ash-boughs not to disconcert the homing bats. The fact, however, that this large and noisy species suddenly ceases to be either visible or audible about an hour and twenty minutes after sunset weighed strongly against the idea of its continuing on the wing all night. Other considerations also pointed to the probability of its retiring early, as the Noctule is known to do. . . . Dr Alcock had drawn my attention to the fact that Hairy-armed Bats shot by him an hour after sunset had their stomachs so crammed with food that it seemed a physical impossibility they could feed much longer.

"I therefore argued that since I could not detect the bats going *in* in the evening, I must endeavour to catch them as they came *out* in the morning. This would at least prove the fact, though not the time, of their retirement after dusk. So, on the night of August 12th, I fixed a net at midnight over the mouth of the hole. In the early morning hours of the 13th I watched by this net . . . and at 3.15 A.M. heard a Bat gently flop into it. I found that I had secured a fine female . . .

[1] "In explanation of these figures, I should state that at Ballyhyland (lat. 52° 31′ N., long. 6° 43′ W.) sunrise on August 10th is 4 minutes later than at Dublin, and sunset 1 minute earlier."

caught emerging for her morning flight, one hour and twenty-six minutes before sunrise.

"Having made sure of my specimen, I quickly removed the net so as not to disturb the remaining inmates of the hole in their egress. I failed to see any bats emerge—the light being too dim—but at 4.20 had the satisfaction of seeing one re-enter. As this individual cannot have left the hole while the net was over it, the duration of its flight had not exceeded sixty-five minutes.

"In the evening of the same day I saw four bats (the survivors of the colony of five) emerge for their evening flight in quick succession between 7.38 and 7.42, 6 and 10 minutes after sunset; and at 8.53 by a fortunate chance, the moon's rays falling full on the line of flight at the moment, I succeeded in seeing one go in. This was one hour twenty-one minutes after sunset. As the interval between earliest and latest emergence had been so short, the duration of this example's flight had been told with some exactness. It cannot have been on the wing for a *longer* period than 76, or a *shorter* one than 71 minutes.

"We may thus claim to have a set of data, limited in number, but precise as far as they go, determining the flight-time of this local and somewhat imperfectly studied species. It has an evening flight and a morning flight, the two being of about equal duration. The evening flight is usually commenced a little earlier than 15 minutes after sunset, the average of seventeen actual emergences noted being $13\frac{1}{2}$ minutes, the earliest 1 minute, the latest 23 minutes, and the mean between the extremes 12 minutes after sunset. The bat returns at night to the same hole as serves it for a sleeping apartment by day; the precise time of its return, in the only instance noted, having been 81 minutes after sunset. Its moment of leaving the hole in the morning has also been noted only once, in the case of the specimen caught on August 13th; but it should be remembered that this individual must have been the *first* to emerge on the date in question, and therefore the usual time of emergence is probably a little later than 86 minutes before sunrise. The time of going home in the morning, on an average of five observations, is 26 minutes before sunrise, the

earliest and latest instances having been 33 and 21 minutes before the sun. It has been shown that the duration of one individual's (evening) flight was at least 71 minutes, whilst that of another's (morning flight) was not more than 65 minutes. The usual duration is, in all probability, not far from the mean between these two figures. The animal, therefore, in summer, spends one-tenth of its time on the wing, and the remaining nine-tenths in its sleeping-hole. In the shortness of its flight-time it is probably unique among Irish bats."

In its hibernation this species appears to differ from the Noctule in that, instead of collecting in numbers for the winter sleep, the slight evidence which we possess seems to indicate that it scatters and hibernates singly. Mr Moffat, watching the daily flight of the bats in September, found that early in the month they deserted their summer quarters and bestowed themselves in separate crevices in the higher parts of the same tree. They migrated singly on different dates. "On Sept. 10th three (instead of four) emerged from the common den; on the 11th, two; on the 13th, none. This shows that they changed their abode voluntarily; if they had been disturbed or alarmed, they would all have left at once. They still fly every evening from their new quarters. No two inhabit the same hole," a description borne out by Mr Finn's solitary Carlow individual, then probably in its winter quarters.

The flight of Leisler's Bat resembles that of the Noctule, but, as stated above, Tomes believed it to be a little less regular in its haunts and less definite in its area of flight than the larger species; and in Wexford, where I have seen it flying at a considerable elevation, I cannot be sure of finding it in any particular spot. Further, the colony in the stable wall resented disturbance, and has departed. Mr Moffat, however, informs me that in localities where it is abundant, as at Enniskerry in Wicklow, it may be observed evening after evening in fairly numerous groups.

At his own home at Ballyhyland, Wexford, the bats on emerging from their den go off almost invariably in the same direction. He found when he intercepted their line of flight that they passed certain points more than a quarter of a mile away with great regularity, still dashing along as if bound for a fixed

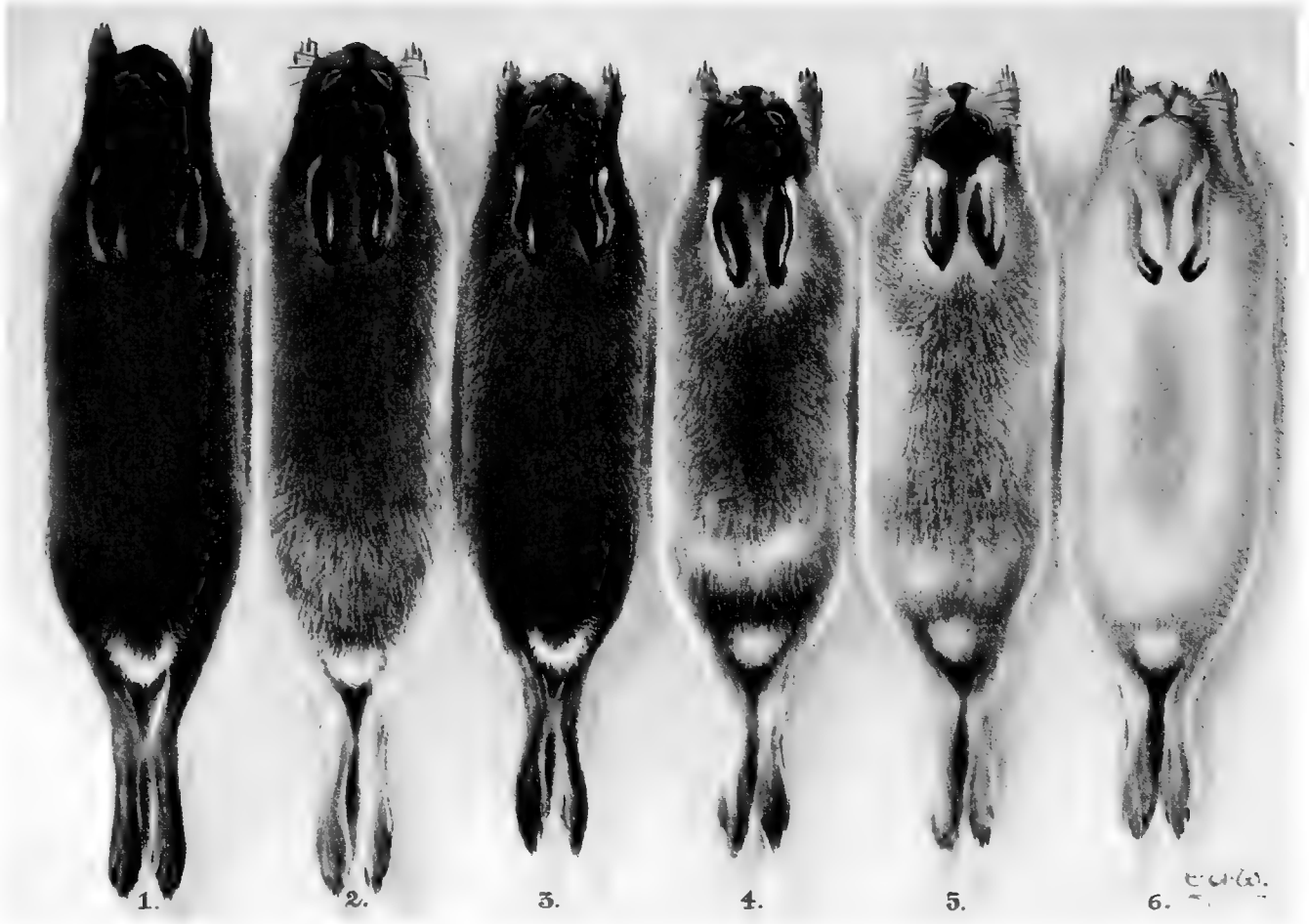
destination; which shows that they range to some distance in search of food. They are fond of frequenting cattle pastures; but here not only, like the Noctule, do they vary their hunting-grounds with the season, but also with the hour, having apparently regular feeding-grounds both for the early and late parts of the evening. Thus the pasture attracts them to a certain extent from May to September; but until midsummer, when the cattle occupy it, the bats fly in it for only a few minutes each evening, just before retiring for the night. During the late summer months the half-hour before retirement is spent in careering about the field.

Dr Alcock writes of this bat[1] that "at first it commonly flies at a considerable height, in open country taking long sweeps and wide zigzags, often being seen but once in an evening. Near woods and in favourable localities it will often remain for some little time near one spot, flying at an altitude of 30 to 40 feet, with a faster and less irregular flight than the Pipistrelle, the tail being extended at a straight line with the body. Later on, it flies near the ground, very commonly shrieking loudly, and I have observed two Bats at this time chasing one another . . . both flying very fast, and screaming."

Mr Moffat has observed a curious peculiarity of the flight. When a bat is hunting insects at a considerable elevation, the observer who is high enough, say, on a hillside, to secure a horizontal view of it, may notice that its motions consist of a regular succession of very gradual ascents and abrupt descents. Mr Moffat suggests that the descent is merely a means of keeping the bat in the plane where its favourite food abounds; at all events the regularity of the process is very striking, and leads almost to the inference that they may be additional to those already described movements of similar regularity in the Noctule which Tomes has otherwise interpreted.

According to Mr Moffat, the cry of Leisler's Bat, when flying in company, is a shrill strong screech, which he judges, although without opportunity of actual comparison, to be shriller and stronger than that of the Noctule. There is besides "a peculiar 'tinkling' song emitted by a single bat when flying alone; when a second appears it is greeted with

[1] *Irish Naturalist*, 1899, 169-174, and map.



1 and 2, IRISH HARE—Summer and Winter. (½ natural size.)

3 to 6, SCOTTISH BLUE HARE—(3) Summer; (6) Winter; (4) and (5) Intermediate. (½ natural size.)

the shrill screech, and from that time one hears the tinkling no more." It is to the "tinkle" and not to the screech, Mr Moffat thinks, that Dr Alcock referred when he stated that the cry of this species is moderately high in pitch, corresponding to about 17,000 vibrations per second of Galton's whistle, and that a fair imitation of it may be made by "striking a sixpenny piece against a halfpenny."

A Leisler's Bat was kept alive by William Darragh in 1858, for ten days. Later, Dr Alcock, Mr Moffat, Mrs Oldfield Thomas (in the latter case Mr Finn's specimen), and Mr Whitaker[1] have kept various individuals in captivity for some little time. Under such circumstances it is an interesting and cleanly pet, devoid of fear, and easily trained to come for its food on hearing a particular sound. It is more active in a confined space than the Noctule, but soon becomes lazy, and, although it will, if necessary, fly to and settle on the hand that feeds it, at other times it takes the earliest opportunity of alighting. But when once it has alighted it is active enough, scurrying round tables, and even falling off on to the floor.

Dr Alcock describes a live one, which he received on 13th February. It remained in a typical state of hibernation until 11th March, when it awoke to be fed, returning to sleep on cold weather again setting in, and thus being in alternate torpidity and vigour until its untimely death on 6th April. Another, kept under observation by Mr Whitaker from 27th September to 16th April, passed through somewhat similar alternations.

In appetite this bat does not fall behind its congener. Individuals shot while on the wing, which could not have been flying for more than an hour, are described by Mr Moffat as "monstrously full—so round and firm and hard (almost like cricket-balls), with the quantity of insect food they had gorged in that short interval." Others submitted to Prof. G. H. Carpenter by Dr Alcock were found to have been feeding largely on flies. Professor Carpenter was also able to identify, amongst other insects, the yellow-haired dung-fly,[2] a midge,[3] besides legs and wings of caddis-flies, and, as Mr Moffat informs me, a

[1] *Naturalist*, 1907, 387, 415, etc. [2] *Scatophaga stercoraria.*
[3] Probably a mycetophilid, also an acalypterate muscid.

beetle. The latter naturalist has observed the capture of moths of fair size by this bat while on the wing.

In captivity it will eat raw meat and drink milk, and Mr Whitaker estimates its daily requirements in mealworms, which were in no case pouched, at about five dozen to each bat. One kept in confinement by Mr Moffat, which he fed exclusively on insects for a week, refused various house-flies, as well as the blue-bottle,[1] common crane-fly,[2] and horse-fly,[3] but enjoyed the common volucella. She partook with relish of the honey-bee and of five species of wasp. A humble-bee[4] and a red-tailed bee[5] were eaten, but subsequent specimens of the former were declined. A few small beetles were promptly devoured. Above all, she evinced an extraordinary partiality for the common cockroach, of which she was known to eat nearly a third of her weight in one night.

"Next to the cockroach, I think her favourite food (among the insects offered) was the honey-bee, when *dead;* but she showed the greatest horror when I offered her a *living* bee, though I held it securely in my hand, and had previously extracted its sting. This was no mere accident, for the experiment was repeated on successive days. In two instances she managed, apparently by a sudden 'flick' of her tongue, to throw the bee to a distance. At first I was surprised that this nocturnal mammal should so well comprehend the offensive capabilities of a day-flying insect; but when we remember the common propensity of both . . . to take up their abode in hollow trees, it is at once seen to be quite natural that they should know something of each other's powers. The identical ash-tree in which the Hairy-armed Bats now under notice reside has often been occupied by bee-swarms."

Leisler's Bat has on more than one occasion been taken in houses, for entering which, however, it seems, like the Noctule, to have but little proclivity, its flight being usually high in the air and away from buildings.[6] There remain many aspects of its life-history in regard to which we possess no information. In particular, as to its breeding habits, we have almost

[1] *Calliphora erythrocephala.* [2] *Tipula oleracea.*
[3] *Hæmatopota pluvialis.* [4] *Bombus terrestris.* [5] *B. lapidarius.*
[6] Moffat, *Irish Naturalist*, 1897, 135; Jameson, *Irish Naturalist*, 1896, 94.

to fall back upon Blasius' statement, that in Germany it is pregnant in June, and that the young may be seen flying with their parents before autumn. Tomes[1] examined two females each containing one fœtus, and another now in the possession of Mr Barrington, and taken at Crum Castle, County Fermanagh, Ireland, in June, had attached to her a single young one; so that it is probable that, as with the Noctule, whatever may be the case in Germany, the number of young in Britain is usually one.

Again, as regards the relative numbers of the sexes and their association or separation when in hibernation, there is nothing to add to what has already been stated in the article on the Noctule. A party of six females, found by Mr Whitaker[2] in a hollow tree in Yorkshire on 22nd August, may be supposed to have just finished rearing their young.

The habits of Leisler's Bat, or of its representatives, would appear to differ somewhat in the different parts of its range. Thus, in Germany, according to Blasius, it may be observed on the wing in the shade of thick woods, where it always flies at mid-day; a remark which is fully borne out by the series of the Azorean form[3] obtained by Messrs W. R. Ogilvie-Grant and the Hon. N. C. Rothschild, and which were shot while flying in or near pine-woods, between the hours of noon and dusk, and frequently in bright sunshine. No similar observation has been recorded for Britain, except that of Mr P. E. Freke,[4] who near Milltown Bridge, County Dublin, at half-past ten o'clock on the morning of 22nd June 1881 watched a bat (which from his description could not well have been of any species other than the present) hawking for flies on the river Dodder, in company with numbers of swallows and swifts.

British naturalists who take an interest in mammals should search carefully for this mysterious bat, which even a practised observer finds difficult to distinguish from the Noctule when on the wing. Mr Coward, one of the few English naturalists since Tomes who has had opportunities of comparing the two, informs me that its flight is slower and more erratic than that of the dashing and rapid Noctule, but even he is not

[1] *Zoologist*, 1854, 4365.
[2] *Naturalist*, 1907, 385-6.
[3] *N. azoreum*.
[4] *Zoologist*, 1882, 16.

invariably able to recognise them. In the hand, the smaller size, darker colour, the absence of the peculiar smell, and especially the markedly smaller feet, cannot fail to form an infallible criterion as between even the very youngest Noctules and the present species.

Genus PIPISTRELLUS.

1829. PIPISTRELLUS, Jakob Kaup, *System der Europäischen Thierwelt*, i., 98; based on *Vespertilio pipistrellus* of Schreber.

1838. ROMICIA, J. E. Gray, *Mag. Zool. and Bot.*, 495; based on *R. calcarata* of Gray =*P. kuhlii* (Natterer).

1839. VESPERUGO, A. Graf von Keyserling and J. H. Blasius, Wiegmann's *Archiv für Naturgeschichte*, i., 312 (part); based on *Vespertilio serotinus* of Schreber and eleven other species (see under NYCTALUS).

1840. ROMICIUS, Edward Blyth, Cuvier's *Animal Kingdom*, 75; misprint for ROMICIA.

1856. HYPSUGO, F. A. Kolenati, *Allgemeine deutsche Naturhist. Zeitung* (Dresden), Neue Folge, ii., 131, 167-169; based on *Vesperugo maurus* of Blasius, and *V. kraschenininkowii* of Eversmann.

1856. NANNUGO, F. A. Kolenati, *op. cit.*, 131, 169-171; based on *Vesperugo nathusii* of Keyserling and Blasius, *Vespertilio pipistrellus* of Daubenton, and *V. kuhlii* of Natterer.

1878. VESPERUGO, G. E. Dobson, *Catalogue of the Chiroptera in the Collection of the British Museum*, 183 (part); included also NYCTALUS, VESPERTILIO, and others.

1893. VESPERUGO, Harrison Allen, *Bull. U.S. National Museum*, 43, 121.

Classification and synonymy:—The explanation of the use of the genus *Nyctalus* applies also to *Pipistrellus*, which presents no further difficulties.

In **characters**, the bats of this genus differ from those of the preceding in their smaller size, lighter build, and shorter, broader wing (Plate VII., Fig. 2, p. 86), attached to the base of the outer toe, not to the middle of the sole. The third and fifth metacarpals are about of equal length, and the tail is usually about as long as the body without the head. The tragus lacks the prominent rounded head, being broadest below its centre, and narrowed, not expanded, above (Fig. 2, No. 3, p. 7). The foot is small.

The **skull** (Fig. 8, No. 1), as exemplified by that of *P. pipistrellus*, is small, weak, and rounded; the facial region is saddle-shaped, namely, concave posteriorly, convex anteriorly; the premaxillary gap is moderately marked; the zygomata are weak; cranial crests are absent or hardly



LEISLER'S BATS. (Approximately natural size.)

perceptible, and the auditory bullæ are more prominent than in *Myotis*, less so than in *Barbastella*.

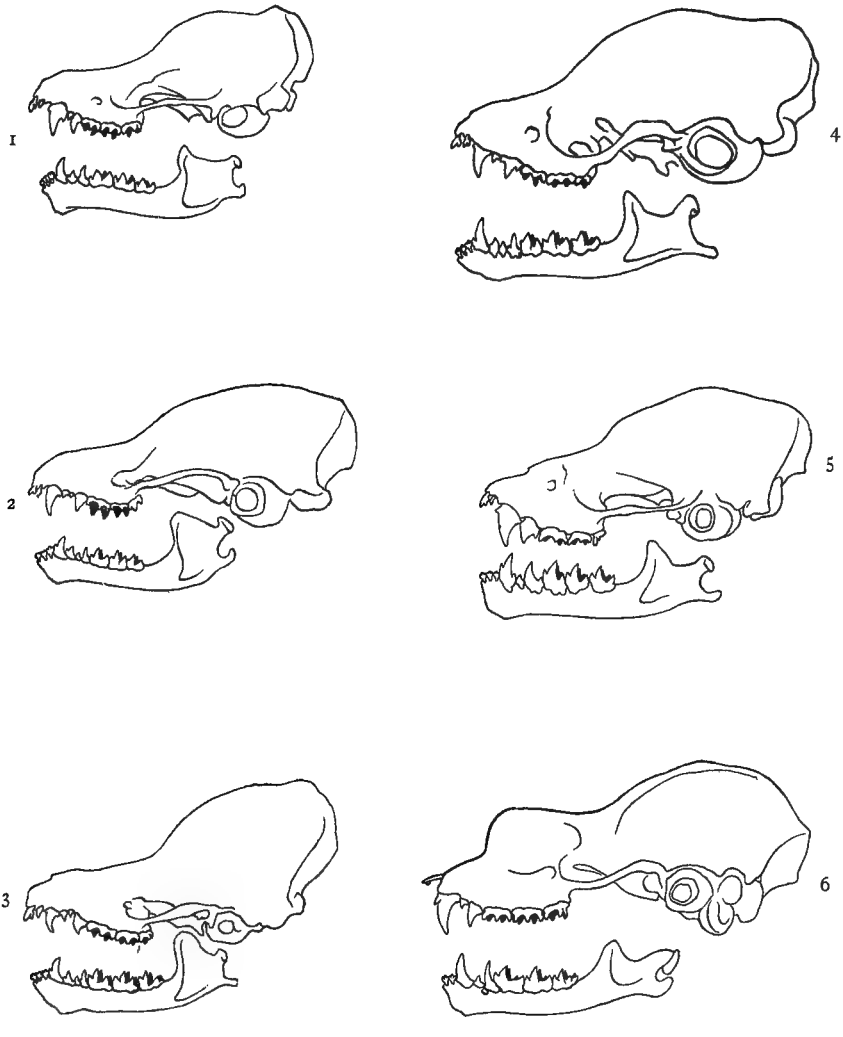
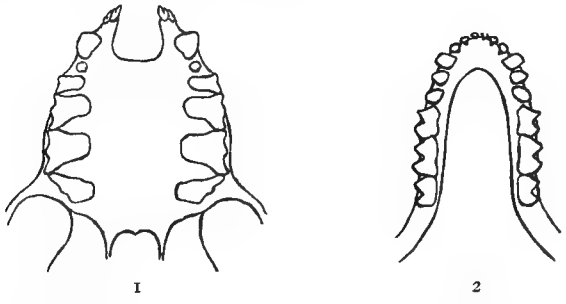


FIG. 8.—SIDE VIEW (diagrammatic and enlarged) OF SKULLS AND TEETH OF

1. *Pipistrellus pipistrellus.*
2. *Myotis daubentoni.*
3. *M. mystacinus.*
4. *Plecotus auritus.*
5. *Barbastella barbastellus.*
6. *Rhinolophus hipposideros.*

The **teeth** are similar in number and arrangement to those of *Nyctalus*, but the inner upper incisor is both more bicuspid

and more prominent than the outer, while the anterior upper premolar is moderately large and usually takes its place in the tooth-row (Figs. 9 and 10, p. 108).



1 2

FIG. 9.—DIAGRAM OF ARRANGEMENT OF TEETH OF *Pipistrellus pipistrellus*.
(1) Upper and (2) Lower Jaw.

The genus includes a large number of species of wide **distribution**, of which at least three occur extensively in southern North America, from austral zones south to Vera Cruz. In the Old World it is represented from Tasmania —*P. tasmaniensis* (Gould)—to Ireland. The single British representative is the well-known *P. pipistrellus*, which in the east and south is replaced by the closely-allied *P. abramus* (Temminck). The latter has a larger forearm (34 to 35 mm.), more naked muzzle, and the anterior upper premolar so small as to be scarcely visible from without. It is believed to range from Australia and Japan through the Malay Peninsula, Ceylon, Assam, Burma, and India, migrating in summer to central Europe, and has been reported from Cadillac, Gironde, France (Trouessart, *Le Naturaliste*, 1879, 16, 125), and Sweden. But its reputed occurrences in Europe should no doubt be credited to *P. nathusii* (Keyserling and Blasius), with light-coloured posterior wing-border and long lower canine, described as of central Europe. Of other species, *P. kuhlii* (Natterer), a southern form, also taken at Gironde, and with a sub-species reaching Cape Colony (*P. kuhlii fuscatus* of Thomas), has the posterior border of the wings white and the outer upper incisor minute; *P. savii* (Bonaparte), a form of wide Palæarctic range, with a representative—*P. albolimbatus* (Küster)—in Sardinia, and shown by Forsyth Major (*Atti della*

Soc. Toscana di Sci. Nat., 3, fasc. 1, 87, Pisa, 1877) to be synonymous with *maurus* of Blasius and *bonaparti* of Savi, has the forearm reaching 34 mm., the tragus broadest at its middle, and having two small lobes projecting from its hinder border, and a broad callosity on the foot; *P. subflavus* (Cuvier) of North America, has the thumb larger, and the forearm reaching 34 mm.

THE COMMON BAT, PIPISTRELLE OR FLITTER-MOUSE.

PIPISTRELLUS PIPISTRELLUS (Schreber).

1667. FLITTER-MOUSE, or REAR-MOUSE, Christopher Merrett, *Pinax*, 172.

1693. VESPERTILIO: The Bat or Flittermouse, John Ray, *Synopsis Quadrupedum*, 243.

1760. LA PIPISTRELLE, L. J. M. Daubenton in E. L. le Clerc, Comte de Buffon's *Histoire Naturelle*, viii., 129-130, 135, 137, pl. xix., fig. 1; also, *Mém. de l'Acad. Roy. des Sci.*, 381, pl. i. (14), fig. 3, 1759, published 1765; described from France.

1766. SHORT-EARED BAT, Thomas Pennant, *British Zoology*, ed. 1, 55.

1775. VESPERTILIO PIPISTRELLUS, J. C. D. von Schreber, *Die Säugthiere*, i., pl. liv., 167, evidently naming Daubenton's *La Pipistrelle;* Jenyns, *Trans. Linnean Soc.* (London), xvi., 163, read 3rd Feb. 1829, published 1833; Bell (ed. 1); Clermont; Flower and Lydekker.

1789. VESPERTILIO MURINUS, Gilbert White, *Selborne*, letter xi. to Thomas Pennant, 9th Sept. 1767, original edition, 32; Berkenhout; Bingley; Donovan; Fleming; not V. MURINUS of Linnæus, 1758 = (probably) V. DISCOLOR of Natterer; not V. MURINUS of most continental writers = MYOTIS MYOSOTIS (Bechstein).

1811. VESPERTILIO PIPISTRELLA, P. S. Pallas, *Zoographia Rosso-Asiatica*, i., 123, No. 48.

1825. VESPERTILIO PYGMÆUS, W. E. Leach, *Zoological Journal*, i., 560, pl. xxii.; figured by Bell in both editions; described from a young specimen taken at Spitchweek, Dartmoor, England, and now in the British Museum.

1829. PIPISTRELLUS PIPISTRELLUS, Jakob Kaup, *System der Europäischen Thierwelt*, i., 98; Miller, *Ann. and Mag. Nat. Hist.*, Oct. 1897, 384; Thomas, *Zoologist*, 1898, 100; Johnston; Méhely; Cabrera; Millais, 79.

1833. VESPERTILIO BRACHYOTUS, L. A. F. Baillon, *Mém. de la Soc. Roy. d'Emulation d'Abbeville*, 50; an unrecognisable species, probably referable to *pipistrellus;* described from a specimen (*collo super. nigro*) from Abbeville, France.

1838. SCOTOPHILUS MURINUS, J. E. Gray, *Mag. Zool. and Bot.*, 497; MaçGillivray.

1839. VESPERUGO PIPISTRELLUS, A. Graf von Keyserling and J. H. Blasius, Wiegmann's *Archiv für Naturgeschichte*, i., 321; Blasius; Fatio; Dobson; Blanford; Lydekker.

1840. VESPERTILIO MINUTISSIMUS, Heinrich Schinz, *Europäische Fauna*, i., 9; described from Zurich, Switzerland (type in Zurich Museum).

1840. "V. MELANOPTERUS et STENOTUS, Brehm," *auct. et op. cit.;* described from Renthendorf, Thuringia, Germany, and Switzerland.

1840. "V. PUSILLUS, Brehm," *auct. et op. cit.*

1840. VESPERTILIO LACTEUS, C. J. Temminck, *Monographies de Mammalogie*, ii., 245 (for date see Wiegmann's *Archiv*, 1841, 23); described from two nearly white, immature bats of doubtful origin in the Leiden Museum (see Dobson, *Catalogue*, 225).

1841. VESPERTILIO VISPISTRELLUS, C. L., Prince Bonaparte, *Fauna Italica*, i., pl. xi., fig. 1; described from Italy.

1842. KERIVOULA GRISEUS, J. E. Gray, *Ann. and Mag. Nat. Hist.*, December, 258; described from a spirit specimen of unknown origin in the British Museum (Dobson, *Catalogue*, 225).

1844. VESPERTILIO NIGRANS, J. Crespon, *Faune Méridionale*, i., 24, is thus placed by E. L. Trouessart, *Bull. de la Soc. d'Étude des Sci. Nat. de Nîmes*, 7, 1, 55, 1879; and, on the authority of Paul Gervais, identified with *P. pipistrellus* though slightly smaller; it was described from Nîmes, France. But Gervais, *Histoire Naturelle des Mammifères*, i., 216, 1854, cites *V. nigrans* next to *pipistrellus*, but as a distinct species, under the name of *V. nigricans* Gené: this is evidently not *V. nigricans* of Maximilian, 1826, which antedates it.

1856. NANNUGO PIPISTRELLUS, F. A. Kolenati, *Allgemeine deutsche Naturhist. Zeitung* (Dresden), Neue Folge, ii., 131, 170.

1858. NANNUGO MINUTISSIMUS, F. A. Kolenati, *Sitzungsberichte der Kaiserlichen Akad. der Wissenschaften* (Vienna), xxviii. (3), 246, and xxix. (10), 334, fig. 7.

1862-1863. NANNUGO PIPISTRELLUS, α, var. TYPUS, p. 490; β, var. FLAVESCENS, p. 491; γ, var. NIGRICANS, p. 491; δ, var. LIMBATUS, p. 492; Carl Koch, *Jahrbücher des Vereins für Naturkunde im Herzogthum* (Nassau), xviii., 487-500; described from Nassau, Germany.

1870. VESPERUGO MINUTISSIMUS, L. J. Fitzinger, *Sitzungsberichte der Kaiserlichen Akad. der Wissenschaften* (Vienna), lxii. (1), 252.

1874. SCOTOPHILUS PIPISTRELLUS, Thomas Bell, *History of British Quadrupeds*, ed. 2, 34; E. T. Newton, *Quart. Journ. Geol. Soc.* (London), 1894, 193.

La Chauve-Souris, or *la Pipistrelle* of the French; *die Zwergfledermaus* of the Germans.

Synonymy:—This presents no difficulty. Those who object to the *Scomber scomber* principle will probably find the combination *Pipistrellus pygmæus* (Leach) correct.

Local Names (non-Celtic):—Athern-bird, of Somerset (Forbes); back-bearaway[1] (black-bear-away, Forbes), of Yorkshire (Atkinson, *Zoologist*, 1878, 330; and *Forty Years in a Moorland Parish*, 1892, 137), from back,[2] backie, bak, bakke, bauckie, baukie, or bawkie, an old form of bat, having variants in Denmark, Iceland (compare *ledhrblaka*, i.e., leather-flapper), Norway (compare Old Norse *blaka*, i.e., to flap), and Sweden (compare *nattblacka*, i.e., a bat), and still used in Scotland, often in combination as backie-bird, etc. (Alston); barnmouse, bastat, bathy-

[1] A word usually applied to ships, and probably meaning sailing or floating away (Wright).

[2] Compare—

> "The laverock and the lark, The baukie and the bat,
> The heather-bleet, the miresnipe, How mony birds be that?"
> —CHAMBERS, *Popular Rhymes of Scotland* (ed. 1870), 198.

mouse (Forbes); bat-mouse, of Stafford (Adams, MS.); batty mouse, billy-bat (*Plecotus*, Wright); bit-bat (Forbes), blin'bat, *i.e.*, blind-bat, of Kirkcudbright (Service, *Zoologist*, 1878, 427); blind-bat, of Dublin (Moffat, MS.); brere-mus (Forbes), (?) = reremouse; chipper, *i.e.*, chirruper, from its cry of "chip, chip" (Forbes); flickermouse (Ben Jonson), as in *New Inn*, iii., 1—

> "Once a bat, and ever a bat! a rere mouse,
> And a bird o' twilight; . . .
> Come, I will see the flickermouse";

flinder (Forbes), compare Dutch *vlinder*, i.e., a butterfly; flinder-, flinter-, *i.e.*, butterfly-mouse (compare in Caxton's *Reynard the Fox* (1481), 112, ed. Arber—

> "Thenne cam . . . the flyndermows and the wezel";

fliner (Forbes); fletter-, flit-, flitter- (or vlitter-) mouse, flitty, flitty-mouse, fluttermouse (compare German *fledermaus*), of many counties, *e.g.*, Yorkshire (Atkinson, *op. cit.*) and Essex (Laver), as in Ben Jonson's *Alchemist*, v., 2—

> "My fine flitter-mouse,
> My bird o' the night;"

glaik of Lothian (Forbes), *i.e.*, a transient glance or gleam; haddabat (Miller and Skertchley, *Fenland*, 1878, 358); hatbat (Forbes); leathern mouse, leathern wings (Forbes); leather-winged bat of Wexford (Moffat, MS.); mouse bat, of Buckingham and Berkshire (Cocks, *Zoologist*, 1878, 334); oagar-triunse, of Shetland (Forbes), (?) = -hiunse, -hinnse or -hunch, *i.e.*, a frightful creature (Wright); pipistrelle, mostly a book-name, from French *pipistrelle*, from Italian *pipistrello*, *vipistrello*, *vespistrello*, variants or diminutives of *vespertillo* or *vespertilio*, from Latin *vespertilio*, i.e., a bat; raamis, ramished, raamouse, raamse, raird, ramsh, rare, rare-, rattle-, rye-, and ry-mouse, rawmil, rawmouse, rawmp, ray-mouse (Gloucestershire), rearie, rearmouse, reelrall, reelymouse, reeraw, reerd, reerie, being mostly words signifying riot or confusion, or connected with reermouse, and reremouse, from middle English reremous, and Anglo-Saxon hréremús, from *hréran*, i.e., to move, shake, stir, and *mús*, i.e., a mouse, as in—

> "Some war with rere-mice for their leathern wings,
> To make my small elves coats"
> —SHAKESPEARE, *Midsummer Night's Dream*, Act ii., Sc. iii.;

rannermouse (Bingley), rannymouse, of south Hampshire (Corbin, *Zoologist*, 1878, 429), see under SHREW.

(Celtic):—Most usually *ialtag* or *ialtog*, with variants *dialtog*, *fialtag* or *taltag*, perhaps from *iall* = leather, sometimes combined with *leathair*, i.e., leather *ialtag*; *craicneach* (?) = *craicneog*, i.e., skinny, as in Man (see Kermode); *callah* or *cal-luch*, and *feascarluch*, *mioltog leathair*,

i.e., leather fly; *sciathan leathair*, i.e., leather wings; *ystlum*, as in Wales; see under NOCTULE (Alston; Forbes; O'Connell; Wilde, *Proc. Roy. Irish Acad.*, vii., 189, 9th and 25th May 1859, published 1862.)

Distribution:—Pipistrelle-like bats occur throughout boreal and transitional Europe and Asia, from sea-level to 6000 feet in the Alps (Blasius), from about 60 N. lat. in Skandinavia, Russia, and Asia, to the Mediterranean, with the Balearics (Barcelo, but not found by Thomas and Pocock), Sicily, the Caucasus, Ural, and Altai ranges, Kashmir valley and Gilgit (Blanford), and from Ireland to an unknown point in Siberia or China. In austral and transitional zones the direct representative in North America is *P. subflavus* of the eastern United States.

From north to south of the **British Isles** this species is probably numerous in every locality where bats can exist, and it was until recent years a general assumption that it is everywhere the commonest species. No doubt this is frequently true, especially in the south and east of **England**, where no bat flies more frequently or persistently, or is more easily observed and caught, so that it is almost certain that it is actually the commonest to the eye. But in many localities close observers report that its numbers are equalled or exceeded by those of *Myotis mystacinus*, from which in flight it is with difficulty distinguishable, of *Plecotus auritus* or *Nyctalus noctula*. In Lincoln it outnumbers all the other species together (Caton Haigh), but in parts of Buckingham Cocks finds *P. auritus* more numerous. In the west and north its numbers decrease; thus, although common on the Gloucester side of the Avon, it becomes rare on the Somerset side, and Charbonnier and Lloyd Morgan believe that it may be there replaced by *M. mystacinus*, as Jenyns found to be the case to a great extent at Bath (see Harting, *Zoologist*, 1888, 164). In Shropshire also its numbers are less than those of *P. auritus* (Forrest), and in Merioneth and North Wales generally it is less plentiful than either of the other three species mentioned above. From the north of England similar reports are forthcoming, it being in Cheshire locally less common than *M. mystacinus* (Coward and Oldham), in Yorkshire probably about as numerous as that species or *P. auritus* (Roebuck quoted by Harting, *loc. cit.*, 165), and in Lakeland not so abundant as in the southern counties (Macpherson).

In **Scotland** it is stated to be in most localities much the commonest bat, and to range to the extreme north (Alston), becoming, however, less numerous in Sutherland and rare in Caithness. It must be remembered, however, that this is only a comparative statement, since other bats, except *P. auritus* and *M. daubentoni* are, as a rule, absent from Scotland. For **Ireland**, Lyster Jameson gave a list of twenty-two counties where it is known to occur, and it is certain that it is present also in the remaining ten (see Patterson, *Irish Naturalist*, 1900, 233).

It has probably found its way to every island of any extent, and has been identified from Orkney (Spence, *Ann. Scott. Nat. Hist.*, 1909, 47), Islay, Mull (Alston; Gilmour, *Mag. cit.*, 1897, 191; Russell), the Outer Hebrides (Harvie-Brown and Buckley), Man (where Kermode considers it common, and whence Oldham has received a specimen), Anglesey (Coward and Oldham), Wight (More; Wadham), and the Scillys (Clark). It is probably the species which has been observed in Shetland (hibernating in a peat stack, Tulloch, *Mag. cit.*, 1904, 125; also Millais), Jura (by myself), the Blaskets (Kane, *Irish Naturalist*, 1897, 88), and other Irish islands, and at such outlying lighthouses as the Fastnet, Rockabill, and Blackrock, Co. Mayo (Barrington, *Migration of Birds*, 284). It is common in all the Channel Islands (Bunting). So diverse are its haunts that, although reaching an altitude of at least 750 feet at Carmichael, Scotland (Watt), it finds a sustenance equally well in the heart of the largest towns, even of London (Rendall, *Zoologist*, 1888, 24).

Distribution in time:—Pleistocene remains from Ightham Fissure, Kent, have been provisionally referred to this species by E. T. Newton (*Quarterly Journ. Geol. Soc.*, 1st May 1894, 193).

Period of gestation:—At least forty-four days (A. Whitaker, *Naturalist*, 1907, 74, and in lit.), but see under NOCTULE.

Number of young and **breeding season**:—The (in Britain) single young one is born sometime between late June and early August. Continental naturalists write of two young ones at a birth as not unusual.

Description:—The form and general characteristics of *P. pipistrellus* are those of its genus. The ear when laid forward reaches to a point about half-way between eye and nostril. The exterior margin is more deeply notched than in *Nyctalus* (Fig. 2, No. 3, p. 7; for head, see Plate XI., Fig. 4, p. 140).

The **fur** is long and thick, and almost hides the round, very small eyes; above the anterior angle of each is a small wart, from which grow a few black hairs; on the forehead a transverse tuft of long upright hair alters the apparent contour of the face, making the forehead appear comparatively prominent, whereas it is in reality depressed in contrast to the well-developed glandular prominences of the muzzle. The furring of the wing resembles that of *Nyctalus*, but there is no carpal band. The interfemoral membrane is furred above nearly as far as a line drawn between the ankles when the tail and interfemoral membrane are extended; beneath, the fur passes on to the membrane only at the root of the tail and along the inner side of the thighs, about half the remaining portion being covered with fine short hairs extending principally along the tail.

The **colour** of the upper side varies between "mars brown" and "Prouts brown," with tendencies towards "wood brown" and even "clove brown"; the lower side is lighter. The hidden portions of the

hairs are everywhere dusky, the dusky basal portion reaching a length of 7 mm. out of a total of 10 mm. on the back. The wing, leg, foot, ear, nose, and naked parts are dusky. The young are generally of a more uniform, usually a darker, colour than the adults, owing to the absence of the grizzled hair-tips, but there are exceptions, as in one labelled 5th August, which is about the lightest individual which I have seen (see Jenyns; Fatio; Couch, *Zoologist*, 1853, 3942).

Nothing is known of the **seasonal changes** of this species, but I believe that they resemble those of the genus *Nyctalus*, since there seems to be a tendency to deeper tints in March and to comparative pallor in summer until August. There are certainly no marked changes, and such as occur are obscured by individual variation.

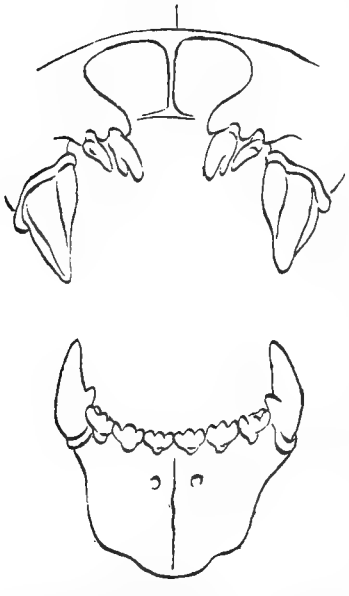


FIG. 10.—FRONT VIEW OF INCISORS AND CANINES OF *Pipistrellus pipistrellus* (enlarged and diagrammatic).

Two young ones (Plate II., Fig. 2, p. 16), born in the possession of Whitaker had at birth a few straggling hairs on the muzzle; the body was dull flesh colour, the wing and ear darker, but lighter than in an adult. One was abnormal in that it neither advanced in size nor apparent development for a month. The other began to grow darker after about five days, and by the twenty-first day the whole body had become dusky. The eyes opened on the eighth day, and about the same time hair began to appear on the back and shoulders, later on the head and chin, lastly on the breast: the belly, however, was still naked on the thirty-third day, when the animal died.

The **skull** and **teeth** are typical of the genus (Figs. 8, No. 1, p. 101; 9, p. 102; and 10).

Individual variation is very frequent, and tends in three directions, *i.e.*, towards melanism, erythrism, and albinism, intermediates of every description being plentiful. One in the Grosvenor Museum, Chester, killed in that city on 6th April 1896, is "coal black, with a rusty tinge on the belly and flanks" (Oldham). Borrer mentions a rusty red one (*Zoologist*, 1874, 4125), and there is an example of this type in the Royal Scottish Museum at Edinburgh. Of all-white specimens, with or without pink eyes, I know of about seven altogether (see Pelly, *Field*, 14th Sept. 1889, 408, and J. M., *Journ. cit.*, 2nd Oct. 1875, 368; Millais, 85; and one in Tring Museum). In the most remarkable the wings and ears were white like tissue paper, the legs, arms, digits, nose and

lips pinkish white, but the fur was only slightly paler than usual (Charbonnier, *Zoologist*, 1901, 472).

Very little is known about the **geographical variation** of this species. Eastern European examples are larger than those of the west, and particularly of Britain. They have been distinguished as the sub-species *macropterus* (*Verhandlungen der kaiserlich-königlichen zool.-bot. Gesellschaft* (Vienna), xii., 1862, 250), described by Zeittelles, from Kaschau, Hungary. Cabrera's sub-species *mediterraneus*, of the east of Spain, is of a clearer red colour, and is said to present some structural differences. Blanford states that Indian examples from dry, sandy regions are paler, and sometimes have the underside almost white, and this is the case also in the deserts of Turkestan, where the representative sub-species is *lacteus* of Temminck (Thomas, *Ann. and Mag. Nat. Hist.*, March 1909, 258), and of a Quetta specimen in the British Museum.

DIMENSIONS IN MILLIMETRES[1]:—

	Head and body.	Ear, greatest length.	Tragus, greatest length.	Tail.	Lower leg.	Hind foot, without claws.	Forearm.	Thumb, without claw.	Longest digit.	Metacarpal III.	Metacarpal V.	Greatest expanse of wings.
Males.												
No. of Items	9	..	..	9	4	12	12	..	..	..	..	3
Maximum	44·5	..	..	34	11·75	6·75	30	..	..	..	..	212
Average	42	10·00	4·00	31·85	10·5	5·65	29·5	3·5-5	50	25	25	208
Minimum	39	..	..	29·2	10	4	27·5	..	..	..	..	206
Females.												
No. of Items	11	..	..	11	5	5	11	..	..	..	..	6
Maximum	52	..	..	33	12	8	31·25	.	..	..	..	218·5
Average	43·35	10·00	4·00	30·5	11·36	7·14	30·28	3·5-5	50	25	25	213
Minimum	34·5	..	..	29·21	10·5	6·75	29	.	..	..	..	203

[1] For these I am partly indebted to Whitaker. The table suggests that, as in the Noctule, females may be slightly larger than males.

Four young males in the Dublin Museum, taken at Bohoe Church, Co. Fermanagh, Ireland, by Lyster Jameson, have the forearm measuring 19·5, 24·5 (two), and 26·5 respectively. Couch (*Zoologist*, 1853, 3942) found the extent of wing varying between 175 and 210. The following approximate dimensions of an embryo almost ready for birth were sent me by Coward:—head and body 25, ear 3·5, tail 10,

hind-foot 3, forearm 12, thumb 2·5, digit iii. 13, digit iv. 10, digit v. 10, expanse 70.

Proportionate lengths:—Foot, without claws, about ·55 to ·62 of lower leg; fifth metacarpal about equal to third; lower leg about ·30 to ·35 of forearm, and about ·25 of head and body.

Skull:—Greatest length, 12·5; basal length in middle line, 9·5; palatal length in middle line, 5; from posterior border of m^3 to anterior border of canine, 4·25; same in lower jaw, 5; greatest breadth at zygoma, 8; posterior breadth, 6·5; breadth between orbits, 4; breadth at constriction, 3·75.

Weight in grammes:—Couch (*loc. cit.*) weighed 28, young and old, in July, and found them varying from 2·6 to 5·4 (40 to 83 grains): Moffat (*Irish Naturalist*, 1900, 235) gives the weight as from 4·5 to 5·8 (70 to 90 grains): while Eagle Clarke sends me the following details—two males, alive, Dec., 5·53 (86 grains) and 4·63 (72 grains); one, 9th May, 4·5; one, 23rd April, 4.4; one, 9th May, 4·5: females, one, 8th Sept., 6·3; one, 10th April, 5·15; one, 9th May, 4·5; one (young), 9th Sept., 4.

Distinguishing characteristics:—In the present state of our knowledge any small bat having an expanse less than 220 mm. may be assumed to be an example of this species until proved to the contrary. Its size at once distinguishes it from the British members of the genera *Nyctalus* and *Vespertilio*, its ears from *Plecotus*, *Barbastella*, and *Rhinolophus*, leaving only *Myotis*, of which two species, *bechsteini* and *nattereri*, are distinctly larger; *daubentoni* is less so, but has distinct coloration and markedly larger foot; *mystacinus* is of somewhat similar size, but its thirty-eight teeth, longer oval ears with their outer margins terminating anteriorly about under the base of the tragus instead of near the angle of the mouth, attenuated tragus, and the total absence of a post-calcarial lobe, are sufficiently distinctive. On the chance of *P. nathusii* occurring in England it would be well to remember that this species has the hinder border of the wing light coloured.

The Pipistrelle is the smallest British bat—in fact the smallest British mammal—its weight about equalling that of the Pigmy Shrew, which for long held the reputation of being the tiniest. By the older English naturalists it was confused with the Common Bat[1] of continental writers, a very different animal, and one having no claim to be regarded as British. This error appears to have originated in the days of Pennant, perhaps with Gilbert White himself, but was frequently repeated until Fleming's

[1] *Vespertilio murinus*, not of Linnæus = *Myotis myosotis* (Bechstein).

time, to be at length dispelled by Leonard Jenyns, who reviewed the whole question in 1829, and clearly demonstrated that the Common Bat of Britain is the Pipistrelle of European zoologists.

The widespread abundance of this bat, the lengthened duration of its period of activity, and its love for the neighbourhood of dwellings, make it to most people more familiar than any other, if we except only the Long-eared, which is in many localities as common. The only species likely to be mistaken for it is the Whiskered, which it closely resembles in size, in mode of flight, and in many of its habits. So close is the resemblance that when flying it is no easy matter to distinguish them. However, it is believed generally that, while the Whiskered Bat often feeds amongst trees, snatching its prey while at rest on the leaves or branches, the Pipistrelle usually feeds near them, and takes its food preferably on the wing. Even this distinction, however, may not bear investigation, and the difficulties surrounding the observation of small bats on the wing are so numerous, that the differentiation of these two species in life must be regarded as one of the most difficult tasks which confront a field naturalist in Britain.

Sometimes the Pipistrelle flies alone in some sequestered nook; at other times, especially on windy evenings, a number will gather together to tread an aerial dance, the passing by of two at close range often leading to a spirited encounter and chase. The small area over which it hunts, and the frequently restricted extent of its beat are very noticeable, and Mr Charles Oldham tells me that this is also true even when the animal is flying over open country, where there is no natural boundary such as a wall, house or fence. It is probably one of the species which in winter time appears inside churches, distracting the attention of the congregation from the evening service, and causing scandalised rectors to set forth their grievances in the public press in hopes that some zoologist may point the way to relief.[1] It was, perhaps, this trespassing in churches that led to the inclusion of bats in the churchwardens' accounts of the parishes of St Paul's, Bedford, and Dean in Bedfordshire,

[1] *Field*, 23rd June 1906, 1044.

wherein, as Mr J. Steele Elliot has shown,[1] they made their appearance between the years 1797 and 1838 in the lists of malefactors for whose head a reward was paid. In the latter parish no fewer than eight hundred and fifty-two bats of one kind or another were killed and paid for at the rate of sixpence a dozen; and, indeed, their deaths cannot be altogether regarded as judicial murders, since they often become a well-nigh intolerable nuisance. At Claxby Rectory, Lincolnshire, where, as Mr J. G. Millais relates, a wall had to be pulled down before a large colony could be ejected, their squeaks and scratchings and their odour were at one time unbearable. Again, Mr Oxley Grabham states that the station-master's house at North Grimston, Yorkshire, was so overrun by the parasites emerging from a colony of two or three hundred bats as to lead to its destruction.

In its choice of nocturnal haunts the Pipistrelle is very catholic. Wherever the Whiskered Bat is seen, this species may be seen also. Its favourite resorts are sheltered corners of an orchard, stack- or farm-yard, a lane, or indeed any other quiet spot, most often near a homestead, gardens, or woodland clearing. Here it may be observed night after night, just before dusk, and at about the same time as, but usually a few minutes before, the Noctule. Time after time it pursues the same round, occasionally varying it by excursions to sport in mid-air with some comrade on an adjacent beat, or to snatch a brief visit to some neighbouring hunting-ground; at intervals it disappears altogether for a few minutes, but generally returns to its accustomed circle, and thus continues until darkness hides it from view. Backwards and forwards, round and round, it flits with noiseless wing-beats, sometimes at an altitude of fifteen or twenty feet above the ground, sometimes much lower. Frequently it darts with wonderful activity, now here, now there, or pursues a minute and to human eyes invisible prey into the corners of buildings, descending if need be to within a few inches of the ground. It seems, like the swallow, to seek its food in the neighbourhood of animals, and will visit the cattle in their sheds, or flit about a man's head until a whip or butterfly-net cuts its flight short. So

[1] *Zoologist*, 1906, 165 and 167.

abundant is it that it is often easy to have several bats in view at the same moment, and so familiar that, as far as the dusk will permit, the shape of the wings—despite the extreme rapidity of their motion—may be traced with the eye. The interfemoral membrane appears to be extended nearly horizontally, the ears are distinctly visible, and certain indefinable lumps on the wings in front and behind suggest the thumbs and feet, the latter, as far as I can make out, carried projecting backwards.

It must not be thought, however, that this bat is by any means entirely confined to a lowly or monotonous flight. Sometimes, as R. F. Tomes noticed, it accompanies Daubenton's Bat in its water-patrols, occasionally dipping its nose in the liquid to slake its thirst. At other times, as Mr T. A. Coward informs me, it flutters slow and moth-like around the tops of trees, its wings appearing on such occasions much broader than usual. Its appearance to Mr William Evans, while out wild-fowl shooting amongst the sand-hills of Aberlady Bay, Haddingtonshire, indicates that it may travel to considerable distances in search of food, and may even find its way out to sea, since Mr R. M. Barrington[1] reports that one was found dead on the Arklow South Lightship, some miles off the south-eastern coast of Ireland, on 21st September 1898. Possibly this particular bat had been blown out to sea, since we have no evidence that the species is migratory.

As the autumn evenings darken, the Pipistrelle issues forth each night at an earlier hour,[2] but its hibernation, at least in the southern districts both of England and Ireland, is a very uncertain and evidently a perfunctory affair. Although, in the north, in all probability, many individuals enter upon their winter sleep before the end of October, there is in the south no night of the year on which, should the weather be propitious, this species or the Whiskered Bat may not be found abroad. These winter flights have often been noticed. Jonathan Couch[3] kept a day-to-day record of them in Cornwall in the years 1852-53, and Jenyns concluded that they are more frequent before than after Christmas.

[1] *The Migration of Birds*, 284 (R. H. Porter, London, 1900).

[2] For some notes of the time of appearance, relative to sunset, see *Fauna of Cheshire*, 12.

[3] *Zoologist*, 1853, 3936-3943.

More recently, Mr C. B. Moffat[1] has taken the trouble to compare the movements of bats, hedgehogs, and frogs from 26th October 1901 to 21st February 1902, as observed at Ballyhyland, County Wexford, Ireland. His facts are carefully tabulated, and mark a distinct advance in our knowledge of the winter routine of three very different types of animals. He finds that bats (and he thinks that practically in every case they were Pipistrelles) "were observed on nineteen evenings in November, nine evenings in December, ten evenings in January, and five evenings in February." He therefore concludes that at "all times during the winter, provided the temperature of the hour of dusk is above 43° Fahrenheit, some Bats of the common species are pretty sure to be found flying, if looked for in suitable localities. Below 43° their emergence is not to be calculated on, but it sometimes takes place at lower temperatures, down to 39°.[2] It will be noticed that a return of mild weather brings out the Bats immediately, no matter how frosty the previous nights and days may have been. The reason why so few Bats were seen during February was that the whole of that month—until the last week, when they reappeared—was continuously cold."

Discussing the possibility that not all these observations referred to the present species, Mr Moffat admits that he is unable to distinguish it from the Whiskered Bat, which also occurs at Ballyhyland. But he contends that, although a few of the latter may have been noted in his table as Pipistrelles, yet his general results would not be thereby affected, and I think the same remark applies to the records of other observers. Most of the bats which he saw at low temperatures cannot, he believes, have been other than Pipistrelles; and in point of fact he saw one captured on 28th December 1901, when the temperature stood at 43½° Fahrenheit.

Mr Moffat's conclusions may, I think, be regarded as sound so far as concerns the winter flights of the Common Bat in the south-east of Ireland, and his limitations may be taken as approximately correct; in fact I can myself corroborate them for the same county, where at Kilmanock

[1] *Irish Naturalist*, 1904, 81-87.

[2] The corresponding figures as given by Jenyns are 40° and 38° F.

on windy winter evenings the Pipistrelle may be found hunting within the shelter provided by a large partially open cattle-shed. Bats have, however, been on occasions observed to fly at temperatures below 38° Fahrenheit, as when Captain L. H. Irby,[1] on 2nd January 1887, observed one on the wing in Surrey in bright sunshine at noon, the ground being covered with snow and the temperature below the freezing-point—an observation repeated by Mr G. H. Caton Haigh[2] at Grainsby, Lincolnshire, on the 10th of the same month, in similar conditions as regards weather, but in bright moonlight.

The partiality of small bats of some species for mid-day flights is well known, and their frequent appearances seem to show that they can have no inherently strong objection to daylight. But the identification of such flights with the Pipistrelle can only rest on conjecture, and at the present stage of our knowledge it is quite beyond possibility to say which species makes the most frequent appearances by daylight. The evidence brought forward by good observers is, however, on the whole, inclined to connect them chiefly with the Whiskered Bat. Whatever be the truth, bats which venture out at such unorthodox hours must fain submit to the persecutions to which the original in general are subjected, and have sometimes, as Couch[3] has observed, been driven back to their dens by the angry attacks of scandalised birds.

The fondness of this animal for different species of gnats has been observed from the time when Pliny[4] wrote (although probably of a different species), "*Et in cibatu culices gratissimi*," and it is probable that these little flies constitute no small part of its usual food. But, judging from its habits in captivity, it doubtless consumes a variety of insects. According to Mr Caton Haigh,[5] it frequently captures comparatively large insects, the well-known "daddy-long-legs" or crane-fly being one of its favourites, while Mr Millais states that it devours

[1] *Zoologist*, 1887, 69. [2] *Ibid.*, 1887, 143. [3] *Op. cit.*, 1853, 3942.

[4] *C. Plinii secundi Naturalis Historiae*, ed. of Joannes Harduinus, lib. x., cap. lxi. (lxxxi.), 454 (Paris), 1685 ("and for food gnats [are] very pleasant [to it]").

[5] *Zoologist*, 1887, 293.

large quantities of the smaller moths; and Mr Moffat has noticed that when it secures anything of formidable proportions, it invariably disappears for a few minutes, unlike the larger Leisler's Bat, which does not permit the struggles of any insect to interrupt its flight.

Mr Moffat has taken considerable pains to show that, unlike that of the Noctule and Leisler's Bat, the flight of the Pipistrelle is continued all night: and this in spite of the fact that the majority of British naturalists, from Dobson[1] to Mr Millais, with the exception of William MacGillivray and a few others, seem to have taken it for granted that this species, like others which are without nasal appendages, must be more properly crepuscular than nocturnal in its habits. Mr Moffat writes:[2]—

"Of course, in observing Bats, one must be very careful that one knows what sort of Bat one is observing. The difficulty of being quite certain on that point vitiates a good many observations that might otherwise be useful. However, I began my enquiries into the Pipistrelle's habits by passing a night in the open air in bright moonlight, in a spot where large numbers of Bats generally fly. The result of this preliminary mode of enquiry (on the night of August 21st-22nd, 1899) was that I found that there were lots of Bats visible on the wing at all hours throughout the night, as well as in the clear light of early morning. That was not conclusive, because, in the first place, these Bats might not all have been Pipistrelles, and, even if they were, some might have gone home early and others come out late, so that there was no proof that any individual Bat, Pipistrelle or otherwise, had been flying about the whole time. The next thing to do was, therefore, to find out where some of these Bats went in the morning. By watching on several mornings, in the summers of 1899 and 1900, I ultimately got the retreats of half a dozen, each living a perfectly solitary life in a little den of its own—some in holes in walls, and some in the trunks of trees. That made it possible to play the detective on these six individuals, and I soon found that the hours of all six were very similar,

[1] *Catalogue of Chiroptera*, xvii., footnote, 1878.
[2] *Irish Naturalist*, 1905, 101-103.

and, on the whole, very regular. Each of them left its retreat every evening during the half-hour after sunset, and returned to it every morning during the hour before sunrise. The time of emergence would, indeed, vary, even for the same individual Bat, from so early as ten minutes to so late as thirty minutes after sunset, and the time of retreat similarly varied from so early as forty to so late as eighteen minutes before sunrise; but in no instance did a Bat, whose sleeping-place was known, on occasions when I watched for its emergence, fail to come out during the evening twilight, or when I looked for its return in the morning, disappoint my expectation of seeing it go in. After ascertaining this much concerning their habits, I caught three of these animals as they were coming out, and they proved to be Pipistrelles. I have no doubt that the remaining three were the same. That does not tell us all that we want to know, but it tells us something. Not only is it known that a good many Pipistrelles are on the wing during the hour before sunrise, but it is also established that these are the same individual Pipistrelles which left their retreats early after sunset the previous evening, and not, as might be imagined, mere belated individuals that had overslept themselves before coming out, and were making up for it by breakfasting late.

"But no amount of mere watching, moonlight or otherwise, would tell whether these animals remained away from their sleeping-places all night, or whether they follow the Hairy-armed Bats' rule of taking a midnight nap. So, on the night of August 16th, 1900, I did what I had done four nights previously in the case of the Hairy-armed Bat, and fixed a net at midnight over a hole which a Pipistrelle had quitted the previous evening twenty-eight minutes after sunset. The result was the opposite to what had happened in the case of the Hairy-armed Bat. At 3.45 in the morning no Bat had come out of the hole, and as it now wanted only an hour to sunrise, it was time to remove the net so as to let the Bat in. Of course I kept watch to see that it did go in, and at twenty minutes past four—some twenty-eight minutes before sunrise—I had the gratification of seeing it make its usual return. Now there could be no doubt, in the case of that animal, that it

had been out all night. All that remained was to make sure —a very important matter—that I was right concerning its species; so the next evening I set the net again over the same hole, caught the Bat as it came out, and found that it was a male Pipistrelle.

"The above experiment was made on a fine bright night, so I thought it safer to try it again on another Bat under less comfortable conditions, choosing this time a dark and foggy night, when nobody could suppose that Bats would be specially tempted to fly late. Such a night occurred on August 30th, 1900, when I netted the residence of a second Pipistrelle. The result, however, was just the same as in the former case. No Bat came out after midnight, but, at the usual time before sunrise, the occupant of the hole went in. Hence, it follows that even during raw and foggy nights, when insects might be presumed scarce, the Pipistrelle does not retire into its den, but continues abroad till its usual hour for seeking sanctuary in the twilight of the early morning. I even find that the same thing happens in winter when the nights are warm enough for the Pipistrelle to fly. I have several times seen it at midnight in the long nights of December and January, and though I have not stayed out at that season to see it going home at seven or eight o'clock in the morning, I have trustworthy information from one whose vocation brings him out at these hours (Mr James Kelly, Ballyhyland), that it stays on the wing till nearly daylight—in other words, flies through a sixteen hours' night."

It should be noted that Mr Moffat's results do not altogether agree with those of J. R. Kinahan[1] as quoted, more particularly under Daubenton's Bat. Kinahan's observations show that in a mixed colony of these two species some at least of the bats returned to their den at ten o'clock in the evening in June. In any case, Kinahan's observations, interesting as they are, are not to be compared for completeness with Mr Moffat's, and, as only a minority of the colony were Pipistrelles, are certainly not conclusive. Mr Moffat suggests that, in view of the undoubted difficulty of distinguishing such small bats on a stormy night at ten P.M., Kinahan may have been deceived in what

[1] *Nat. Hist. Review* (Dublin), 1854, 23-24.

he saw, and, perhaps, thought that bats passing close to the wall were returning to their den. The probable truth of the matter is that neither the Pipistrelle nor any other bat is absolutely tied down to habit, but we may be quite sure that its flight is continued off and on throughout the night. That interruptions may be frequent is averred by Mr Arthur Whitaker, who assures me that he has more than once observed a short day-break flight in this species, a fact which I can myself corroborate, having on one occasion observed a Pipistrelle active for about five minutes just before sunrise. It is quite likely that in inclement weather, or where there is a large colony, the bats may come and go throughout the night, perhaps to visit and feed their young or to devour more safely some large insect.

The Pipistrelle is by no means fastidious in its choice of a place of concealment. No kind of crevice, crack, or aperture, whether of tree or building, within or without, comes amiss to it, and in such places it lives either singly or, more particularly in summer, in large parties, the membership of which is not always restricted to its own species; it has no objection to the noisy companionship of man in the neighbourhood of its sleeping-place. The inside of an old and disused wooden pump has on occasion furnished a somewhat remarkable resting-place, a bat having been seen to emerge from the spout. It has been asserted that trees are much less frequented by this species than by some others, but, apart from Mr Moffat's experience, instances are known of its having been discovered hiding behind pieces of loose bark and amongst ivy. The bats sometimes show a preference for some particular retreat; thus Mr Oldham informs me that on 16th June 1888, he took an adult male from behind a window-shutter at a farmhouse in Wisbech Fen, Cambridgeshire. On the 18th he found an adult female on the wall in precisely the same spot, and on the 19th and 21st two other Pipistrelles, also adult females.

If there be any situation to which this bat apparently objects it is to the interior of caves, resting within which, so far as I am aware, it has been but rarely detected, although Mr Coward has found it in secluded rock crevices just outside a cave. It was not amongst the species found by Dr E. A.

Wilson and Mr A. H. Cocks in Mr Heatley Noble's cave at Henley-on-Thames, nor does Monsieur Gadeau de Kerville[1] include it amongst the seven species revealed by a three hours' search in the "Grotte de la Briqueterie, Seine-Inférieure," France. In fact, he states expressly that he has never met with it in such situations.

There is some evidence to show that, like the Noctule and Leisler's Bat, the Pipistrelle regularly varies its hiding-place with the season, the sleeping-places of summer being frequently distinct from the hibernacula of winter. One such instance has been placed on record by Mr F. Boyes,[2] who knew of a retreat at Bishop Burton, near Beverley, from which no fewer than one hundred and twenty-six Pipistrelles had been counted as they emerged in summer, yet it was deserted in winter. In its winter retreats, at all events, the animal is often solitary, but immense troops gather together in summer. In these, unlike the Noctule and Leisler's Bat, both sexes participate, and a Hampshire colony was estimated by Mr Whitaker to include from three to four hundred individuals.[3]

The voice of the Pipistrelle is feeble when compared with that of the larger bats, and can only be appreciated by sharp ears, but Ovid was clearly guilty of poetic imagination when he wrote of it that "*Minimam pro corpore vocem emittunt.*"[4] In truth, the little creature shrieks with might and main when irritated, and it is hardly its fault, its gamut not being intended for human ears, that its efforts are to most of us barely perceptible. Mr Oldham remarks that individual bats differ widely in the matter and manner of their utterings.

As with other bats, the breeding season is probably autumnal, but hiemal activity is accompanied by desultory pairing of the extent of which we are ignorant. Messrs R. Rollinat and E. L. Trouessart,[5] whose interesting researches on the breeding habits of bats have been already discussed at length, are quite firm in their assertion that, no matter how frequently such winter breeding may take place, as they admit it does, fecundation is retarded until spring

[1] *Bull. Soc. Amis Sci. Nat.* (Rouen), 4th April 1901, reprint, 2.
[2] *Field*, 29th August 1903, 405.
[3] *Naturalist*, 1907, 77.
[4] *Metamorphoses*, lib. iv., 10.
[5] *Supra*, p. 32.

precisely as in the case of other bats. On the other hand, Mr Whitaker suggests that pairing may take place during the latter half of May, at which time he has noticed bats chasing each other, a fact not necessarily evidence of pairing.[1] Unfortunately, no precise observations exist for Britain. It is, however, certain that the date of birth varies a good deal, at least from late June[2] to early August, but it is never, so far as is known, so early as to be inconsistent with Messrs Rollinat and Trouessart's results. Thus Mr H. Lyster Jameson,[3] when visiting Bohoe Church, Ireland, on 11th July, found a number of young Pipistrelles, from a few days old to half-grown individuals, crawling about the floor of the church, having fallen through a hole in the ceiling. As regards July births, four captive females, in the possession of Mr Whitaker, produced their respective young on the 2nd, 10th, 18th, and 19th; while Mr Coward found an embryo nearly ready for birth in a female killed on the 4th of the same month. The earliest of these would, no doubt, have been born in June, and the possibility of early births is further strengthened by the capture of a young one on the wing on 9th August at Exeter,[4] and of another at Kilmanock, County Wexford, Ireland, on the 13th. Allowing seven weeks each for gestation and rearing, the birth of these two bats must have taken place some time between 21st and 25th June. Their southern habitats sufficiently account for the early date, and it is interesting to note that the Wexford bat was fully grown, although certainly immature.

In two of Mr Whitaker's bats the known period of gestation was not less than forty-one and forty-four days, and in a third it probably reached forty-nine. The mother was captured between 27th and 31st May, had for companions two males of her own species, and when she died on 14th July was found to contain a small embryo, "probably not more than half-

[1] See his "Notes on the Breeding Habits of Bats," *Naturalist*, 1905, 325-330.

[2] A statement by J. J. Briggs (*Zoologist*, 1848, 2278) that the bats in Melbourne Church, Derbyshire, "bring out their young about June 17th," is unfortunately somewhat indefinite as regards the exact species.

[3] *Irish Naturalist*, 1896, 95.

[4] Now in the Exeter Museum, and kindly submitted to me for examination by Edwin Hollis.

developed." If the facts as reported by Mr Whitaker be correct, and assuming that the true period of gestation could not have exceeded some forty-nine days, we are left with the alternative explanations that either the date of ovulation was delayed by captivity, or that either fertilisation or pairing had taken place after the date of capture. The case is full of interest, but does not afford much ground for speculation as to its meaning. It may, however, be expected that the breeding habits of a bat having such slender inclinations to hibernate, must present many features of interest, and will probably be found to vary with the climatic conditions of different parts of its range, as in fact we know to be the case in regard to the number of young.

On the latter point, continental authorities from Pliny—"*Geminos volitat amplexa infantes*"[1]—downwards unite in considering two at a birth quite usual. This is certainly not the case in Britain, where the observations of Tomes, George Daniell, Mr Whitaker, and others show that, as with the Noctule, one is the almost invariable rule. Of five female Pipistrelles received by Daniell[2] in July 1833, each contained a single fœtus; and Tomes also was convinced by the examination not merely of British specimens, but of a great number of foreign ones, that the production at a birth of more than one young one is exceptional. The only (and that an extremely doubtful) British reference to the birth of twins which I have been able to find is the merely incidental statement of Couch, that a friend "observed of one to which the young ones were attached, that they were separated from the teats with difficulty, and that when separated they were not able to lay hold of them; and the old one then seemed quite indifferent to her young, running over them without care." The act of parturition was observed in one case only by Mr Whitaker. The mother clung head downwards to the side of the cage and received her offspring in her right wing, which she held partially extended for the purpose.

The young ones born in Mr Whitaker's cages were at first stowed away under their mother's wings, exactly like

[1] *Loc. cit. supra*, p. 115, "[The mother] flies embracing twin young."
[2] *Proc. Zool. Soc.* (London), 11th Nov. 1834, 129-132.

young Noctules, and in that position were at first hardly visible from without. After a few days the relation between mothers and offspring became much less close, and they began to hang themselves up alone at a distance of a few inches from their parents. When they were a week or two old they usually spent the day, often close together, at the side of the cage opposite to that affected by their mothers, and would sleep quietly by themselves for many hours. When wanting their mothers or when touched, they would lift themselves well up on the wrists, raise the head high and turn it anxiously about from side to side, uttering a chirrup resembling the soft smacking of human lips; this was very faint when the creatures were young, but steadily grew in power as the days went by. This sound was uttered with widely open mouth, and after calling for a while the bat would set off in search of its mother, whom it clearly distinguished from that of its companion, and when found seized with its teeth by any part available. Generally each managed to work its way to a comfortable position under a wing, where, once arrived, the mother would usually bend down her head to "tuck" it in, at which times it could be heard uttering a soft, musical twitter.

If the mother happened to be feeding at the time, she would often take no notice of her young, but would drag it carelessly about, clinging possibly to her interfemoral membrane, or to the fur of her back. Whenever she happened to pause, the youngster would try to improve its grip, and the tenacity with which it clung to her was astonishing, so that it very seldom dropped off, when once it had taken hold. After feeding, the mothers always attended to the young ones immediately. If the baby was under its mother's wing when she came out to feed, it did not hamper her movements very much until it came to pouching a meal-worm; the young one appeared to render this most difficult, and seemed to be very much in the way. This was so much the case that, when the young ones were three weeks old, Mr Whitaker was compelled either to feed the mothers by hand, or to remove the young ones from them whilst they fed.

Mr Whitaker more than once allowed the mothers to fly with their young ones, but they were always very careful, before commencing to do so, to expand the wings fully, and lift them up and down a few times, to ascertain that "baby" was not clinging to the wing itself. They seldom flew for more than five or six times the length of the room with the youngster attached, but when they did so, the youngster was plainly to be seen holding to a nipple with its teeth, and to the fur with its feet, the back being quite arched, so that the young one hung well down from its parent, and was conspicuous enough when the latter was flying in a room in the daylight.

The young Pipistrelles unfortunately did not survive to eat solid food or fly, although the stronger of the two was frequently observed to open and stretch its wings during the last few days before its death on the thirty-second day.

The Pipistrelle has frequently been kept alive for long periods in confinement, and possesses many lively and interesting habits. It is far more active and ready to take wing than the Noctule or Leisler's Bat, and, although irascible to members of its own species, recognises its patrons, circling easily round a room, and soon learning to come to the hand for flies or other dainties.

Bingley long ago showed that captive Pipistrelles are so fearless as to take mealworms from the hand on the very day of their capture. In this they resemble Noctules, and are as a rule much less shy than the Whiskered or the Long-eared Bats. When hungry they are not at all fastidious, and will eat readily small pieces of raw meat, usually refusing such as are not quite fresh and juicy. Their capacity for mealworms, according to Mr Whitaker, reaches thirty a day. They like also many kinds of insects, sometimes eating, sometimes rejecting the wings; but Mr Oldham's specimens could only be induced to touch white butterflies or the yellow-underwing moth after much persuasion, and Mr Whitaker's refused the generally unpalatable magpie moth.

Mr Whitaker has experimented on the senses of this bat in captivity, and writes me that sight and hearing seem the most important used both by it and by bats



FIG. 1.—TYPICAL MOLAR TEETH OF AN INSECTIVOROUS BAT (after Miller).

A. Crown view of upper molar. *B*. Crown view of lower molar.
C. Side view of upper molar.

ecd, entoconid
hc, hypocone
hcd, hypoconid
mc, metacone
mcd, metaconid
ms, mesostyle
mts, metastyle
pc, paracone
pcd, paraconid
prc, protocone
prcd, protoconid
ps, parastyle



FIG. 2.—YOUNG PIPISTRELLE. (Natural size.)

From a specimen in the British Museum, to show the small wings, but large feet and thumbs.



PIPISTRELLE BATS. (About $\frac{3}{4}$ natural size.)

in general when feeding. A Pipistrelle which had become accustomed to picking up mealworms from the floor of its cage, was puzzled by finding a piece of white wool of similar length, but seemed indifferent to bits of black or red wool. It ate two blackened mealworms, but with hesitation, after smelling them carefully, as it did also the white worm-like pieces of wool. On the other hand, it almost sprang upon ordinary mealworms and devoured them, without attempting to smell them. But the peripheral nerves generally must be extremely sensitive, since a temporarily blinded Pipistrelle, liberated with a piece of paper firmly gummed across the front of the tragus, not only flew round a room briskly and without hesitation, but avoided contact with obstacles, and smartly dodged strokes of a net.

Captive Pipistrelles frequently make use of the inter-femoral membrane in the pouch-like manner (Plate VIII., p. 104) which, although undoubtedly observed by older writers, and mentioned by Dobson,[1] appears to have been for the first time thoroughly appreciated and intelligently interpreted by Mr Oldham. The history of this habit is worth recounting at some length. It came under the notice of White,[2] who wrote to Pennant that he was much entertained at the manner in which a tame bat, when fed, "brought its wings round before the mouth, hovering and hiding its head in the manner of birds of prey when they feed." Bingley is more detailed in his description, since he relates how a bat, "raising itself somewhat higher than usual on its fore-legs, bent its head with great dexterity under its belly, and forced the insect into its mouth, by thrusting it, from side to side, against that part of the membrane which extended betwixt the two hind legs." Again, in 1834, Daniell wrote of a bat falling over its prey, "with all its membranes expanded, and cowering over the prostrate fly, with its head thrust under, in order to secure" it. Later, Joseph Clark[3] thus graphically described the attack of a captive bat upon a fly: "If it missed its aim, its next tactic was to use its long arm, to get it under its

[1] *Catalogue of Chiroptera*, xxviii. [2] Letter xi., dated 9th Sept. 1767.
[3] *Zoologist*, 1847, 1766-1767.

body; it would turn and curl the membraneous part of its tail inwards, forming a complete sack, into which, if it succeeded in getting its prey, it would thrust its head for the purpose of capture."

Clark's remarks naturally lead up to the more detailed observations of Mr Oldham, which will be found transcribed at length in the account of the Whiskered Bat. It should be remarked, however, that when making his observations Mr Oldham was quite unaware of those which preceded his; in fact, he is in many respects in a position to correct them, inasmuch as no previous observer had clearly stated that what a bat actually does is to thrust its head, with *the insect actually in its mouth*, into the interfemoral pouch, its object being to prevent the escape of its prey, should it by any chance break loose during its struggles. Mr Oldham finds, however, that a bat only makes use of the pouch when it has to overcome the struggles of a strong insect; at other times it is content to devour its prey with its head entirely in the open.

The inference is that bats make a similar use of the interfemoral pouch while on the wing, but very few naturalists have sufficiently keen eyesight to follow their evolutions while thus engaged in the open. Amongst the few are the late Frank Norton,[1] Professor C. Lloyd Morgan,[2] and Messrs E. D. Cuming and Lionel E. Adams, of whom the first named stated that he had often kept tame Pipistrelles in his house, where they had full liberty of the rooms, and appeared to be well content with the diet of flies thus afforded them. When catching a fly, the bat, so far as he could judge, struck its prey a blow with its wing, which disabled it, and then seized it before it reached the ground, using its tail as a basket until it had obtained a firm hold. Mr Cuming writes somewhat similarly in his pleasant book, *The Arcadian Calendar*,[3] and in reply to my inquiry for further details, he adds the information that he has "often watched the

[1] *Midland Naturalist*, 1883, 149-153, arranged and contributed by H. A. Macpherson.

[2] *Animal Life and Intelligence* (London: Edward Arnold), 1890-1891, 65.

[3] George Newnes, Ltd., London, 1903, 35 (illustrated by J. A. Shepherd).

Pipistrelle swoop through a swarm of gnats, and have, on favourable opportunities, seen the tail depressed to 'bag' the membrane, the animal's flight at same moment—or in the same movement—often turning slightly upward. It appeared to me that this manœuvre could have no other purpose than the capture of insects, and when I found that another observer had recorded the same thing, I accepted it as confirmation of my own opinion, and adopted it as fact." Lastly, Mr Adams informs me that he observed the manœuvre in sunlight on 17th March 1906.

When feeding at large, Pipistrelles, like the Noctule, execute falcon-like swoops on their invisible prey, with the wings evidently spread to their widest extent, so that way is kept on even at the fullest depth of the plunge. On other occasions an intermediate line of action may evidently be taken, since I have seen a remarkable headlong descent, during which one wing was for an instant curiously curved so as almost to enclose the body in front. No doubt, like other animals, bats are not such rigidly red-tape disciplinarians as to be forced to follow a fixed sequence of movements every time they catch a fly. It is probable, therefore, that their plans are varied, the smaller flies being snatched up without trouble, while for the capture of the larger insects the membranes may be to a lesser or greater extent employed, or the struggling victim may even be carried off to be mastered at leisure in some secure retreat.

Genus VESPERTILIO.

1758. Vespertilio, Carolus Linnæus, *Systema Naturæ*, x., 31-32; based on *Vespertilio murinus* of Linnæus (not *V. murinus* of Schreber, 1775, see above, page 51).

1820. Eptesicus, C. S. Rafinesque, *Annals of Nature*, 2; based on *Eptesicus melanops* of Rafinesque = *Vespertilio fuscus* of Beauvois.

1829. Cnephæus, Jakob Kaup, *System der Europäischen Thierwelt*, i., 103; based on *Vespertilio serotinus* of Schreber.

1839. Vesperugo, A. Graf von Keyserling and J. H. Blasius, Wiegmann's *Archiv für Naturgeschichte*, i., 312; based on *Vespertilio serotinus* of Schreber, and eleven other species.

1839. Vesperus (sub-genus), *auct. et op. cit.*, 313; based on the thirty-two toothed species of the genus *Vesperugo*, e.g., *serotinus* of Schreber, *discolor* of Natterer, *nilssoni* of Keyserling and Blasius, *savii* of Bonaparte, *leucippe* of Bonaparte, and

aristippe of Bonaparte; preoccupied by VESPERUS of Latreille, 1829, a genus of *Coleoptera.*

1841. NOCTULA (sub-genus of *Pipistrellus*), C. L., Prince Bonaparte, *Fauna Italica*, i., xxi. (under *Vespertilio alcythoe*); based on *Vespertilio serotinus* of Schreber.

1856. CATEORUS (sub-genus), F. A. Kolenati, *Allgemeine deutsche Naturhist. Zeitung* (Dresden), Neue Folge, ii., 131, 162-163; based on *serotinus*, i.e., *La Serotine* of Daubenton.

1856. METEORUS (sub-genus), F. A. Kolenati, *op. cit.*, ii., 131, 163-167; included *nilssoni* of Blasius, *discolor* of Kuhl, *leucippe*, *aristippe*, and *savii*, all of Bonaparte; preoccupied by METEORUS of Halliday, 1835, a genus of *Hymenoptera.*

1858. AMBLYOTUS, F. A. Kolenati, *Sitzungsberichte der Kaiserlichen Akad. der Wissenschaften* (Vienna), xxix. (9), 252; based on *A. atratus* of Kolenati = *Vesperugo nilssoni* of Keyserling and Blasius.

1863. "ARISTIPPE, F. A. Kolenati, *Beiträge zur Kenntniss der Phthiriomyiarien*, Petersburg, 1863" (thus in Koch, *Das Wesentliche der Chiropteren*, etc., 471, 473, 1863, under *Meteorus*); included *V. discolor* of Natterer = *V. murinus* of Linnæus and *Vesperugo nilssoni* of Keyserling and Blasius.

1864. SCOTOPHILUS, Harrison Allen, *Monograph of the Bats of North America*, 28 (part).

1866. PACHYOMUS, J. E. Gray, *Ann. and Mag. Nat. Hist.*, 90, February; based on *Scotophilus pachyomus* of Tomes.

1870. NYCTIPTENUS, L. J. Fitzinger, *Sitzungsberichte cit. supra*, lxii. (1), 424; based on *Vespertilio smithii* of Wagner.

1872. MARSIPOLÆMUS, W. Peters, *Monatsberichte der Königlich Akad. der Wissenschaften* (Berlin), 260, a sub-genus of *Vesperugo* based on *Vesperus* (*M.*) *albigularis* of Peters = *V. murinus* of Linnæus.

1878. VESPERUGO, G. E. Dobson, *Catalogue of the Chiroptera in the Collection of the British Museum*, 183 (part); included also NYCTALUS, PIPISTRELLUS, and others.

1892. ADELONYCTERIS, Harrison Allen, *Proc. Acad. Nat. Science*, 466, Philadelphia (December 8, 1891); proposed as a substitute for *Vesperus.*

Classification and synonymy:—The use of the generic term *Vespertilio* has been fully explained on pages 50-51.

M. Méhely uses Rafinesque's name *Eptesicus* for the *serotinus-fuscus* group, restricting the name *Vespertilio* to the remainder of the genus as here understood. Mr Thomas has pointed out the objections to this proposal (*Ann. and Mag. Nat. Hist.*, July 1901, 31-32). A more recent arrangement, that of Mr Miller, makes the division between *V. murinus* as sole representative of *Vespertilio*, and the remaining species as *Eptesicus.* This will probably meet with general acceptance, since the short broad tragus and large nares of typical *Vespertilio* are quite characteristic, and not in accord with those of the other members of the genus. The present work was written too early for its adoption.

As defined in the present work, this genus includes a number of species of collectively wide **distribution.** The

best known are, besides *V. serotinus*, *V. nilssoni* of Keyserling and Blasius (= *V. borealis auctorum*) of northern Europe and Siberia generally to the Arctic circle; *V. murinus* of Linnæus (= *V. discolor auctorum*) of the temperate portions of the Palæarctic region, mainly in mountainous districts (for distinctions, see page 140, under *V. murinus*); and Cabrera's *V. ochromixtus* with forearm only 32 mm., in central Spain and the Balearics. There are representatives in North and South America (see under *V. serotinus*).

From those of the preceding genera these bats differ in their slightly smaller, narrower **ear** (Fig. 2, No. 4, p. 7), distinctly longer than broad. The tragus is straight, short, moderately pointed, broadest near the middle, and with a slight forward direction. The **wing** (Plate IX., Fig. 2, p. 126) is broader than in *Nyctalus*, but springs from the base of the toes, as in *Pipistrellus*. There are fewer **teeth** (Fig. 11), the small anterior upper premolar being absent, leaving only four teeth, not five, behind the upper canine, and the formula is thus—

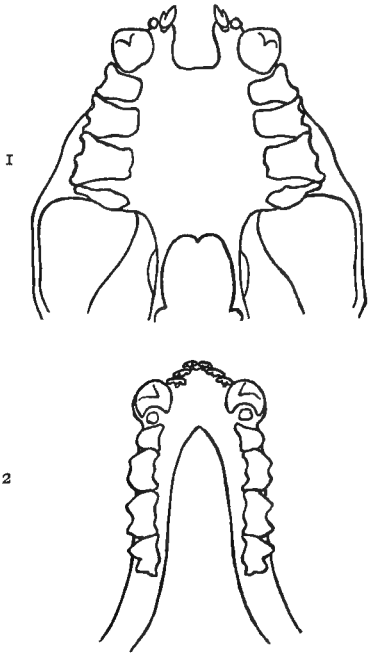


FIG. 11.—DIAGRAM OF ARRANGEMENT OF TEETH OF *Vespertilio serotinus*.
(1) Upper and (2) Lower Jaw.

$$inc\ \frac{2-2}{3-3},\quad c\ \frac{1-1}{1-1},\quad pm\ \frac{1-1}{2-2},\quad m\ \frac{3-3}{3-3} = 32.$$

The **skull** (Fig. 4, No. 2, p. 56), as exemplified by *serotinus*, is heavily built, flattened, larger and altogether stronger than that of *Pipistrellus*, but, as compared with that of *Nyctalus*, longer, less massive, and with more rounded brain-case; the facial region is angular and concave, the premaxillary gap much less marked, the zygomata expanded, the cranial crests posteriorly prominent, the auditory bullæ smaller. In dorsal profile the skull presents nearly a straight line, rising gradually from nose to occiput.

Only one species, *V. serotinus*, is a regular member of the British Fauna, but *V. murinus* has twice been taken at or near seaports.

THE SEROTINE.

VESPERTILIO SEROTINUS, Schreber.

1760. LA SÉROTINE, L. J. M. Daubenton in E. L. le Clerc, Comte de Buffon's *Histoire Naturelle*, viii., 129, pl. xviii., fig. 2 ; also, *Mém. de l'Acad. Roy. des Sci.*, 377 and 380, pl. ii. (15), fig. 2, 1759, published 1765 ; described from France.

1774. VESPERTILIO SEROTINUS, J. C. D. von Schreber, *Die Säugthiere*, 1, pl. liii., 167, evidently naming Daubenton's *La Serotine;* Jenyns ; Bell (ed. 1) ; Clermont ; Dobson ; Flower and Lydekker ; Miller ; Thomas, *Zoologist*, 1898, 100 ; Johnston ; Cabrera ; Millais.

1806. VESPERTILIO NOCTULA, Isidore Geoffroy, *Ann. du Mus. d'Hist. Nat.*, viii., 193, pls. 47 and 48 ; transference of name in error.

1811. VESPERTILIO MURINUS, P. S. Pallas, *Zoographia Rosso-asiatica*, i., 121, No. 46 ; preoccupied by *V. murinus* of Linnæus, 1758.

1811. VESPERTILIO SEROTINA, *auct. et op. cit.*, 123.

1827. VESPERTILIO WIEDII, C. L. Brehm, *Ornis* (Jena), iii., No. 3, 24 ; described from Jena, Germany.

1827. VESPERTILIO OKENI, *auct. et op. cit.*, iii., No. 4, 25 ; described from Jena, Germany.

1829. VESPERTILIO RUFESCENS, *auct. cit.*, Oken's *Isis* (Jena), 643 ; described from Jena, Germany.

1838. SCOTOPHILUS SEROTINUS, J. E. Gray, *Mag. Zool. and Bot.*, 497 ; MacGillivray; Bell (ed. 2).

1839. VESPERUGO (VESPERUS) SEROTINUS, A. Graf von Keyserling and J. H. Blasius, Wiegmann's *Archiv für Naturgeschichte*, i., 313 ; Dobson ; Blanford.

1844. VESPERTILIO INCISIVUS, J. Crespon, *Faune Méridionale*, i., 26 ; described from Nîmes, France.

1844. VESPERTILIO PALUSTRIS, *auct. et op. cit.*, 22 ; described from Nîmes, France.

1856. CATEORUS SEROTINUS, F. A. Kolenati, *Allgemeine deutsche Naturhist. Zeitung* (Dresden), Neue Folge, ii., 131, 162-163.

1857. VESPERUGO SEROTINUS, J. H. Blasius, *Säugethiere Deutschlands*, 76 ; Lydekker.

1862-1863. CATEORUS SEROTINUS, var. TYPUS, var RUFESCENS, and var. PALLIDUS ; Carl Koch, *Jahrbücher des Vereins für Naturkunde im Herzogthum* (Nassau), xviii., 463-467, etc. ; described from middle Europe, south Europe, and the "die steppen Süd-Russlands" respectively : the latter apparently = *V. turcomanus* of Eversmann.

1870. VESPERUS SEROTINUS, L. J. Fitzinger, *Sitzungsberichte der Kaiserlichen Akad. der Wissenschaften* (Vienna), lxii. (1), 88.

1900. EPTESICUS SEROTINUS, Méhely Lajos, *Monographia Chiropterorum Hungariae*, 209, 340, pl. xiv. ; Miller ; Trouessart (1910).

La Sérotine of the French ; *die spätfliegende Fledermaus* of the Germans.

Serotine from the French *sérotin*, from the Latin *serotinus*, *i.e.*, late or backward.

"Rattle-mouse" of Wight (Guyon, *Zoologist*, 1856, 5216).

Distribution:—Bats of this type have a remarkably wide distribution, being found over the greater part of the known world. In the Palæarctic Region they range from north Germany, south Russia, and corresponding latitudes in Siberia southwards to the Barbary States, Asia Minor, Transcaucasia, Arabia, Persia, Kashmir, China, and probably Japan, ascending in the Harz Mountains to 2000, and in the southern Alps to 4000 feet. Representative or allied forms of the old world are mentioned under variation.

In North America the closely allied *V. fuscus* of Beauvois ranges throughout the austral, transitional, and the lower edges of the boreal zones, and has sub-species in (1) Costa Rica, Guatemala, and southern Mexico, (2) in Guatemala and Nicaragua, (3) the Bahamas, (4) Cuba, and probably elsewhere.

In the **British Isles** the Serotine is entirely confined to the south of **England.** The first British record, that of Gray for London in 1826 (*Zoological Journal*, ii., 109), was almost certainly made in error, but it had the effect of introducing the species into the works of Jenyns, Bell (ed. 1), and MacGillivray, to all of whom no other locality was known. In 1846 it attracted the attention of H. N. Turner at Folkestone (*Zoologist*, 1847, 1635), and in or before 1851 of Bury and Borrer in the Isle of Wight (*Journ. cit.*, 1874, 4126), to be followed by Martin's, More's, and Guyon's experience of it in the same island previously to 1854 (*Journ. cit.*, 1854, 4179; see also 1856, 5216). Since then numerous observers have detected it in the south-eastern counties, between the valley of the Thames and the Channel, as in Sussex (Borrer, *Zoologist*, 1874, 4126, and 1893, 223; Lilford, 1887, 65; Ellis, *Field*, 14th Oct. 1893, 597, and *Zoologist*, 1893, 458; Jeffrey, 1894, 261; Butterfield, 1897, 141); in Hampshire (Lilford, *Journ. cit.*, 1887, 65; Kelsall, 1891, 395); in Kent (Harting, *Journ. cit.*, 1890, 380, and 1891, 203; Dowker, 1891, 305 and 424). It appears to be numerous in many parts of Kent. It is rarer, although frequenting many localities, in Sussex, and rarer still in Hampshire. In Wight, fifty years ago, More found it a common species; some later observers describe it as rare, but Wadham finds it very common and widely distributed. Jersey has one record (Bunting).

In the west it is almost unknown, or has escaped notice, but is said to have been obtained near Newquay in 1902, and near Lostwithiel in 1906, and to be not uncommon about Porth (Clark), while one from Tintagel Castle, all in Cornwall, is in the British Museum (see Dobson). D'Urban, in a letter to Hollis, connects with this species certain large bats, of which he saw flights at Exmouth, Devon, on 24th Sept. 1892.

North of the Thames the Serotine must be regarded as very rare. Harting denies its occurrence in Middlesex (*Zoologist*, 1891, 203), and cites, on the authority of Bond, Dartford Heath, Kent, as its

nearest known locality to the metropolis. An Essex specimen killed before 1863 at Coggeshall was detected by Miller Christy in 1883, and another was taken by him in 1894 at Broomfield (*Journ. cit.*, 1883, 173; *Proc. Essex Field Club*, iv., iv., 1892, and *Zoologist*, 1894, 423-424). A third Essex specimen, taken at Pitsea, near Tilbury, in August 1906, was exhibited to the members of the Essex Field Club, by Rev. A. B. Hutton, on 24th November. It was examined and identified by Laver. The first-mentioned locality remains the most northerly authenticated for Britain, although Coburn believes that he once had a Birmingham specimen through his hands (*Zoologist*, 1892, 403). A reputed example in the Newcastle Museum has been examined by Southwell, and proves to be a Noctule (*Journ. cit.*, 1887, 234), and Lilford's belief that it occurs in Northampton (*Journ. cit.*, 1887, 65) may have been founded on a misapprehension.

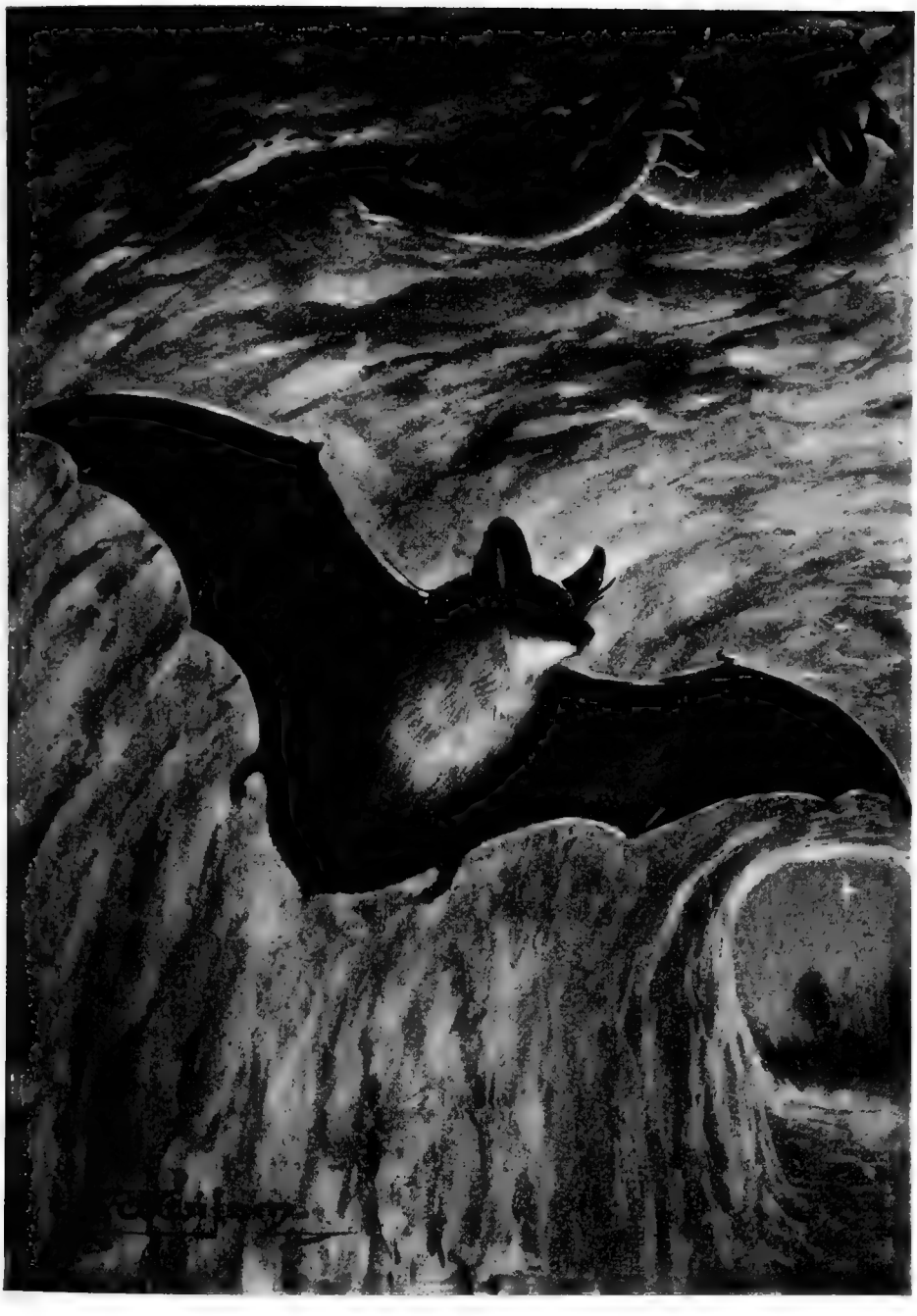
The restricted distribution in Britain of a type of such wide range in the world is very remarkable, and must be regarded as one of the puzzles of British mammalogy, difficult or impossible to account for unless on the supposition that the species is either newly arrived or decreasing its range. The abundance of bats may depend on so many circumstances of which we have little knowledge, that it may be well to note More's statement of this species that in the Isle of Wight it was very common until the felling of the timber.

Distribution in time:—This species is not known in a fossil or semi-fossil condition.

The period of gestation, breeding season, and **number of young** have not been recorded for England; but in Germany, according to Blasius, there is but one young one, born, according to Kuhl (*Op. cit. supra*, p. 83, 1, 191), in the latter half of May: in other respects, this bat is stated to be normal (see page 31, etc.).

Description:—The Serotine is of about the size of the Noctule, but with the **ear** oval (Fig. 2, No 4, p. 7), somewhat triangular, and when flattened out, with the broadly rounded tip reaching to a point about midway between nostril and eye; the outer margin is concave for the upper half, then convex, slightly emarginate opposite the base of the tragus, and ending in a convex lobe behind the angle of the mouth; the inner margin is slightly convex with a rounded basal lobe. The tragus is elongate, broadest just above the base of the inner margin, thence diminishing slowly in breadth to the bluntly pointed tip; its inner margin is straight or slightly concave, the outer convex with a small projecting rounded basal lobe. The tumid face is sparsely haired in front, but with a fringe of stronger hairs on the upper lip; the glands are not so prominent as in *Nyctalus* (Plate IV., Fig. 3, p. 60).

The **wing** (Plate IX., Fig. 2, p. 126) is broader than in *N. noctula*, the lower leg, tail, forearm, and fifth metacarpal being all longer than in



NATTERER'S BAT (⅔ natural size.)

that species. The third metacarpal is slightly shorter than in *noctula*, and is slightly longer than the fifth; the latter is relatively much longer than its forearm. The foot (both actually and relatively) is smaller, and the longest digit shorter. The tail projects markedly from the interfemoral membrane, the last two vertebræ being free. The thumb is longer, and more slender. The total expanse is actually about the same as in *N. noctula*, but is less relatively to the forearm length.

The **fur** is soft and longer than in *Nyctalus*, but on the upper surface extends on to the wing to a lesser degree; beneath, the wing is sprinkled with fine hairs, and on the interfemoral membrane these are restricted to an almost invisible scattering on the transverse dotted lines. As in *N. noctula*, a band of hair may extend from behind the forearm to the carpus, but it is usually much less conspicuous.

The **colour** above is dark, varying between "clove" and "Prouts," or "mummy brown"; many of the hair tips are of tawny shades. The under side affects some tint of "broccoli" brown, often inclining to tawny. The line of demarcation is sometimes moderately distinct, following the wing, and thence running forward beneath the ear to the mouth. The sparsely haired portions of the face are deeply pigmented, as are the wing, interfemoral membrane, limbs, and ear.

Bell states that the juvenile colours are more obscure, and Ruskin Butterfield writes me that the undersides of old specimens are conspicuously darker, but it is not known whether there is any seasonal colour change or **moult**. A very dark female in good condition, shot by Ogilvie-Grant at Yalding, Kent, on 23rd May, suggests that there may be, as in so many bats, two phases, a melanic and a brown, and seems to be contrary to Bell's statement that "the female is much brighter than the male."[1]

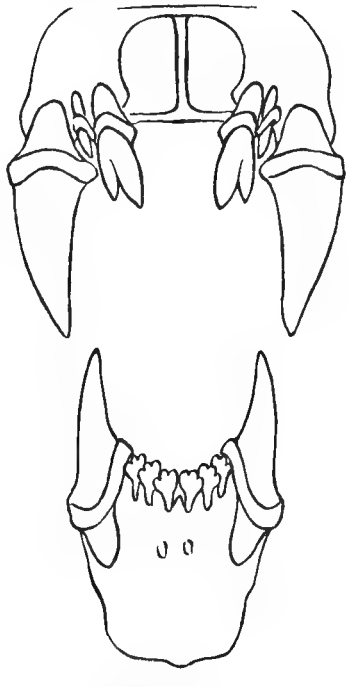


FIG. 12.—FRONT VIEW OF INCISORS AND CANINES OF *Vespertilio serotinus* (enlarged and diagrammatic).

In the **teeth** (Fig. 12) the inner upper incisor is long, strong, and bifid, until worn down: its length is at least double that of the small

[1] A similar sexual coloration is, however, present in *Miniopterus dasythrix* (Temminck) and *M. fraterculus* of Thomas and Schwann (see *Proc. Zool. Soc.* (London), 20th Feb. 1906, 161-162).

outer incisor. The anterior lower premolar attains to about half the breadth and height of the posterior.

Variation:—This species has always been regarded as to a high degree variable, but it is probable that many of its phases will eventually, under modern criticism, prove to be of geographically specific or subspecific value. Little more than a note of the various described forms can here be given. Daday distinguishes a large Transylvanian subspecies as *transylvanus*, and Cabrera one with the forearm measuring 51 mm. from the Balearics as *insularis*; the same author's *boscai* from the Mediterranean coast of Spain was based on a young *serotinus* (Miller). A number of cream-coloured Asiatic bats have been referred to *serotinus*, but at least those bearing the names *isabellinus* (Temminck, 1827, forearm 41, from Tripoli), *turcomanus* (Eversmann, 1840, expanse about 200, from the Aralo-Caspian steppes), and *bottæ* (Peters, 1869, forearm 40, from Botta, Arabia), are clearly not conspecific. *Mirza* (Philippi, 1865, forearm 53), and *shiraziensis* (Dobson, 1871, forearm over 50), both from Persia, may represent desert forms. Blanford's *andersoni* of Yunnan is said to have a smaller foot, while Tomes' *pachyomus* (forearm 52) of India is a distinct bat (Miller, *Proc. Biol. Soc.*, Washington, xiii., 13th June 1900, 155-156). Chinese examples are of dark coloration.

DIMENSIONS IN MILLIMETRES:—

	Head and body.	Ear, greatest length.	Tragus, greatest length.	Tail.	Lower leg.	Hind foot, without claws.	Forearm.	Thumb and claw.	Longest digit.	Metacarpal III.	Metacarpal V.	Greatest expanse of wings.
Male (in the flesh), Essex (Miller Christy, *Zoologist*, 1894, 424) . . .	..	..	..	..	..	..	..	..	..	.	..	355
Male do., Yalding, Kent, 28th July 1906	79	20	8·5	51·5	20	11·5	50·5	8	85	47	47	348
Male, do., Surrey, 6th Aug. (W. R. Ogilvie-Grant) . .	68	19	..	52	22	..	53	..	89	47	43·5	
Male, Brede, Sussex . . .	..	..	..	..	..	..	49	..	..	..	.	.
Female (in the flesh), Yalding, Kent (W. R. Ogilvie-Grant), 7th Aug. 1897 . . .	72	15·5	..	52	20·5	9	53	7	89	49·5	46	354
Female, do., 8th Aug. 1897 .	73	16	..	55	21	10	54	7	87	47	45	355
Female, do., 13th May 1898 .	80	19	..	52	21	..	51	7	84	45·5	41	374
Female, do., 3rd July 1898 .	73	23	6	54	..	..	53·5	6·5	85	48	44·5	374
Female, do., 2nd Oct. 1898 .	73	17	..	48	20·5	10	53	7	90	47	44	365
Female, do., 2nd Oct. 1898 .	75	15		50	21	12	52·5	7	84	45	41·5	356
Female, Surrey, 6th Aug. 1902 (W. R. Ogilvie-Grant) . .	75	20	9	57	..	..	..	..	..	.	..	..
Average of females .	73	17·9	..	52·5	20·8	..	52·8	6·9	86·5	47	43·5	368
Do. of both sexes .	74·2	18·25	..	52·3	20·8	10·5	52·1	7	86·6	47	44	360

Dowker (*Zoologist*, 1891, 425) gives the wing expanse of two Kent specimens as reaching 14·5 and 15 inches = 368·3 and 381 mm.

Proportionate lengths (both sexes):—Foot without claws, about ·50

of lower leg; fifth metacarpal, about ·93 of third; lower leg, about ·39 of forearm and about ·28 of head and body.

Skull:—Greatest length, 21; basal length in middle line, 16; palatal length in middle line, 8·5; from posterior border of third upper molar to anterior border of canine, 7; same in lower jaw, 8·5; greatest breadth at zygoma, 14; posterior breadth, 9; breadth between orbits, 7; breadth at constriction, 4·5.

Weight of a male from Essex, $\frac{5}{8}$ oz. = 113 grammes (Miller Christy, *Zoologist*, 1894, 424).

Distinguishing characters:—As compared with the Noctule, which alone of preceding species is of similar size, this bat is deep brown, with lighter under side, instead of wholly coloured reddish brown; the colour is alone distinctive, but the cumulative evidence of broader wing, longer ear and tragus, slight post-calcarial lobe, and greater length of tail outside the interfemoral membrane, make error in identification impossible.

The Serotine, notwithstanding the clear and intelligible description of its discoverer Daubenton, was mistaken for the Noctule by Isidore Geoffroy, but was well figured in the eighth volume of Buffon's great work. It is in the British Islands only known from the south, and particularly the south-east of England, where it is abundant, and perhaps the commonest bat, a very remarkable fact when it is remembered that outside of Britain probably no bat has a wider distribution.

This fine bat has gained its name from the late hour at which it is supposed to commence its evening flights. But in this respect, and in other aspects of its natural history, it has been frequently confused with the Noctule, and there is no doubt that much that has been written of it is incorrect. Thus, nearly every account of it—and the most original are those of William Borrer,[1] G. B. Buckton,[2] Frederick Bond,[3] and George Dowker[4]—mentions two quite distinct forms of flight, difficult to reconcile as appertaining to the same creature, and inconsistent with the descriptions of the best foreign naturalists. In the first the bat is shown flying with great strength at a high elevation in manner strongly suggestive of the Noctule. In the second it appears as a

[1] *Zoologist*, 1874, 4126. [2] *Proc. Linn. Soc.* (London), 6th Dec. 1853, 260 (1855).
[3] *Field*, 14th March 1874, 263 (quoted by Edward Newman).
[4] *Zoologist*, 1891, 305-306 and 425.

somewhat delicate animal, not daring, as a rule, to venture abroad except when the weather is fine, and seeking the shelter of gardens and orchards, roads or lanes, where it appears in the same haunts from year to year. Its flight is described as low and heavy, and it often flutters with fully expanded wings in manner resembling the members of the genus *Myotis*.

I am indebted to Captain Saville J. Reid for enabling me to arrive at a partial understanding of this apparent confusion. In the grounds of his house at Yalding, Kent, he has long known the Serotine to haunt the lawns and open spaces between the fruit-trees. Here, in the early summer months, a party of ten or twenty of them may be seen circling and twisting round the trees in pursuit of the buzzing cockchafers, which they catch and devour on the wing. Captain Reid's experience early in the year thus bears out the descriptions of those writers who find this bat a sociable, low-flying, glade-haunting species, but he has not observed it actually snatching the insects off the trees, as other writers assert that it does.[1]

On 28th July, when I joined Captain Reid in watching the bats, there were no cockchafers on the wing, and the Serotines, of which there were then only some half-dozen in view, had perforce to look for other food. They now flew higher, often at thirty or forty feet, but not, I think, exceeding the height of tall elms or of gunshot, and often descending near to the ground. Their flight was not unlike that of the Pipistrelle, but their beat was wider and their pace relatively less rapid. They could not be described as weak flyers, nor was their pace slow, but they clearly lacked the dash and finish of the Noctule, one or two of which were present for comparison.

Like other bats, they indulged in frequent swoops and somersaults, evidently in the act of seizing their prey, but the only one heard to utter a sound was a large one, which Mr H. C. Schwann shot to test our identification, and which shrieked before it fell dead to the ground.

To the above notes may be added the information kindly supplied by the Rev. E. N. Bloomfield, of Guestling Rectory,

[1] *E.g.*, Blasius in Germany, Borrer and Bond in England; see *Zoologist*, 1891, 203.

Hastings, that a colony occupying a cavity in the roof of his house, vary their flight with the weather. When a breeze is blowing they seek the shelter of trees, and fly backwards and forwards along the short drive at the Rectory. In calm weather they venture farther afield.

As far then as these very limited observations go, the Serotine usually feeds at moderate, not necessarily humble, elevations. It looks fully as large as the Noctule, but may be distinguished by the breadth of its wings, apart from the two different styles of flight, which suggested to Dowker and to Captain Reid a comparison between snipe and woodcock.

The food evidently varies with the season and opportunity. At Yalding cockchafers seem to be the most highly esteemed, but, when these insects are not present, substitutes must be found, and Buckton saw the bats pursuing white moths,[1] as well as beetles, and successfully angled three of them by means of shreds of white paper attached to an ordinary fishing rod and line. At Yalding, when the cockchafer flights are over, they seek some more congenial hunting-grounds, and by autumn the garden is almost deserted.

Despite its name, the Serotine is an early flier, perhaps the earliest of all British bats. Captain Reid has observed it in numbers soon after eight in the evening in the third week of July, the sun setting at about eight. On the 29th, the sun then setting at a few minutes before eight, several made their appearance at about sunset, the first at about twenty minutes to the hour. Buckton believed that, like the Noctule and Leisler's Bat, this species retires after about an hour's exercise in the evening, and that was the impression which I gained from my brief acquaintance with it; but further study is required before this point can be regarded as settled.[2] I watched for the Yalding bats from a quarter to two to four o'clock on the morning of 29th July, the sun rising at about twenty minutes past four, but without seeing a single one, although a small bat was very busy on the wing for a few minutes at about four.

[1] *Porthesia chrysorrhœa*, Linnæus.

[2] Miller Christy's (Broomfield, Essex) specimen entered a room at 1 A.M., on 25th August, and A. B. Hutton's bat, from the same county, after midnight, on 27th August (Henry Laver in lit.).

In the daytime the Serotine retires to holes, which a number of individuals inhabit in company. They seem to have a preference for cavities under the roofs of houses, and Captain Reid states that they do not object to the presence of other species. Borrer[1] knew of a colony of at least eighteen individuals, while Mr H. G. Jeffery,[2] who sent one to Mr J. E. Harting, has described another of about twenty; but assemblages of numbers rivalling those of the Noctule seem to be unknown.

Hibernation probably commences for the species as a whole in the latter part of October, but several observers have noticed a few on the wing in November,[3] as Mr Percy Wadham in the Isle of Wight until the 10th; he remarks, however, that these late-flying specimens haunt unusual places, and restlessly change their beat every few minutes. The dates of first spring appearances have not been placed on record.

Nothing is known definitely about the breeding habits, except statements by continental naturalists (Blasius and Kuhl) that only one young one is brought forth at a time, its birth taking place generally in the latter half of May, and that in other respects it is not known to differ from other species.

A bat of this species is said to have been kept alive by Mr George Guyon[4] from 3rd January to 7th March 1856. It was taken while hibernating in an old chimney, and immediately after its capture ate some raw meat left with it, and in four days it would take meat from the fingers and allow itself to be stroked. "That it knew me," wrote Mr Guyon, "I would hardly venture to say; but certainly on one occasion it squeaked in alarm when another person offered to touch it, which it never did with me after the first few days."

The Serotine is frequently mistaken for the Noctule, but, except in size, the two have few points of resemblance. The generally darker colour of the Serotine, the lighter under side, broader wings, longer and more pointed ears, and lanceolate tragus, very slightly developed post-calcarial lobe, and failure of the interfemoral membrane to extend to the tail tip, are quite

[1] *Zoologist*, 1893, 223-224. [2] *Ibid.*, 1894, 261.

[3] *E.g.*, Rev. E. N. Bloomfield at Hastings (in lit.); also A. G. More, in Wight, on 3rd Nov.; see *Life and Letters of Alexander Goodman More*, etc., 34, 1898, edited by C. B. Moffat (Dublin: Hodges, Figgis, & Co., Ltd.).

[4] *Zoologist*, 1856, 5216.

diagnostic. Both species have a band of hair on the arm, so that this point is of no value for purposes of determination.

On the wing, the Serotine can only be confused with two other British bats, the Noctule and the Greater Horseshoe. Its flight has already been compared with that of the former, which rarely descends to hunt insects around the lower branches of trees, and both are conspicuous enough to exhibit the different proportions of their wings in flight.

[THE PARTI-COLOURED BAT.

VESPERTILIO MURINUS, Linnæus.[1]

The Parti-coloured Bat was included in the British list by Bell, on the strength of a single specimen taken by W. E. Leach at Plymouth, probably in the early thirties, and now in the British Museum.[2] A second example came into the hands of John Hancock when "either alive or *just dead.*" It was taken (as he wrote to Mr Thomas Southwell), "I am almost sure, on board ship, undoubtedly off Yarmouth Roads, in the year 1834."[3]

The coloration of this species is so remarkable that, were it a true native of Britain, it could not for so long have escaped the attention of zoologists. We may, therefore, conclude that its visits to this country have been entirely accidental. Possibly they may have been effected by the assistance of shipping, or it may be that the individuals which have reached our shores have been blown across the Channel while engaged in the migratory movements which both the Parti-coloured and its ally, Nilsson's Arctic Bat,[4] are believed to perform annually. With the prevailing winds blowing *from* and not *to* the British Isles, however, its frequent occurrence within our boundaries would seem to be improbable.

[1] *Systema Naturæ*, x., 32 (7), 1758: until recently cited as *Vespertilio discolor* of Natterer.

[2] No. 37*a*.

[3] Southwell, *Trans. Norfolk and Norwich Nat. Soc.*, 1873-74, 80; (I am indebted to Southwell for further particulars by letter); E. Newman, *Field*, 7th March 1874, 218, and *Field*, 5th Sept. 1874, 246.

[4] *V. nilssoni.*

It ranges from southern Sweden to Dalmatia, and from France to Asia, and is, perhaps, representative of the American genus *Lasionycteris*.

The rich tints of this species, dark brown marbled with pale yellowish brown, and the strongly contrasted whitish underparts, make it one of the most beautiful of European bats. It may be at once distinguished from the Serotine by its colour and smaller size, the forearm measuring only about 43-45 mm. From Nilsson's Bat also it differs in colour, the latter being deep brown grizzled with tawny above and yellowish brown beneath, in its slightly larger size, the forearm of the latter averaging 39-45 mm., and in having the tragus broadest above, instead of below, the middle of the inner margin.]

GENUS MYOTIS.

1829. MYOTIS, Jakob Kaup, *System der Europäischen Thierwelt*, i., 105-106, 188; based on *Vespertilio murinus* of Schreber (not *V. murinus* of Linnæus); Gray, *Ann. and Mag. Nat. Hist.*, December, 1842, 258.

1829. NYSTACTES, Jakob Kaup, *op. cit.*, i., 106, 108-109; based on *Vespertilio bechsteini* of Leisler; name preoccupied by NYSTACTES of Gloger, 1827, a genus of birds (see Palmer, *Index*, 467, 1904).

1829. VESPERTILIO, Jakob Kaup, *op. cit.*, i., 110; based on *Vespertilio daubentoni*, *V. nattereri*, and *V. mystacinus;* A. Graf von Keyserling and J. H. Blasius, Wiegmann's *Archiv für Naturgeschichte*, i., 307, 1839; Harrison Allen, 1864 and 1893; Dobson, 1878; not VESPERTILIO of Linnæus, 1758.

1830. LEUCONÖE, Friedrich Boie; Oken's *Isis* (Jena), 256-7; based on die Wasserfledermäuse, type *V. daubentonii*.

1841. SELYSIUS, C. L., Prince Bonaparte, *Fauna Italica*, i., introduction (3); based on *Vespertilio mystacinus* of Leisler.

1841. CAPACCINIUS, C. L., Prince Bonaparte, *Fauna Italica*, i., introduction (4); based on *Capaccinius megapodius* of Bonaparte = *Vespertilio capaccinii* of Bonaparte.

1842. TRILATITUS, J. E. Gray, *Ann. and Mag. Nat. Hist.*, 258, December: included *Vespertilio hasseltii* of Temminck, *V. macellus* of Temminck = *V. adversus* of Horsfield and *T. blepotis* of Gray = *Miniopterus* sp.

1849. TRALATITUS, F. L. P. Gervais in Charles D'Orbigny's *Dictionnaire Universel d'hist. Nat.*, xiii., 213; a misprint for *Trilatitus*.

1856. BRACHYOTUS (sub-genus), F. A. Kolenati, *Allgemeine deutsche Naturhist. Zeitung* (Dresden), Neue Folge, ii., 131, 174-177; based on *mystacinus* of Kuhl, *daubentonii* of Kuhl, and *dasycnemus* (*sic*) of Boie; name preoccupied by BRACHYOTUS of Gould, 1837, a genus of birds.

1856. ISOTUS (sub-genus), F. A. Kolenati, *op. cit.*, ii., 131, 177; based on *nattererii* of Kuhl, and *ciliatus* (p. 131) or *emarginatus* of Geoffroy (pp. 177-179).

1856. MYOTUS, F. A. Kolenati, *op. cit.*, ii., 131, 179-181; based on *bechsteinii* of Kuhl and *murinus* of Linnæus.

1866. TRALATITIUS, J. E. Gray, *Ann. and Mag. Nat. Hist.*, 90, February; a misprint for *Trilatitus*.

1867. PTERNOPTERUS, Wilhelm Peters, *Monatsberichte der Königlich Akad. der Wissenschaften* (Berlin), 706; a sub-genus of VESPERTILIO = MYOTIS, based on *P. lobipes* of Peters = *V. muricola* of Hodgson.

1870. EXOCHURUS, L. J. Fitzinger, *Sitzungsberichte der Kaiserlichen Akad. der Wissenschaften* (Vienna), lxii., 1, 75-81; based on *Vespertilio macrodactylus* of Temminck, *V. horsfieldii* of Temminck, and *V. macrotarsus* of Waterhouse.

1870. AEORESTES, L. J. Fitzinger, *op. cit.*, 427-436; included *Vespertilio villosissimus* of Geoffroy, *V. albescens* of Geoffroy, *V. nigricans* of Maximilian, and *V. levis* of Geoffroy.

1870. COMASTES, L. J. Fitzinger, *op. cit.*, 565-579; included *Vespertilio capaccini* of Bonaparte, *V. megapodius* of Temminck, *V. dasycneme* of Boie, and *V. limnophilus* of Temminck.

Classification and synonymy:—As shown by Mr Miller, the genus *Vespertilio* of Linnæus contained none of the large group of bats with thirty-eight teeth, to which the name was applied by Bell and others. These have, moreover, clearly nothing to do with the thirty-two toothed members of that genus as here applied, and have accordingly been allocated by recent writers to the genus *Myotis* of Kaup, the first based upon a member of the group.

This large genus comprises a multitude of species, some of which are found in nearly all tropical and temperate regions of the globe, so that the area of their **distribution** is probably unexcelled in extent by that of any other bats.

There are four British species — *daubentoni*, *mystacinus*, the rare *bechsteini*, and *nattereri*. A fifth, the common continental *M. myosotis* (see page 190), has often been included in works on British natural history, but is certainly not a regular inhabitant of this country; a sixth, *M. emarginatus*, is stated to have occurred once (see page 189). Other European species are *M. capaccini* of Bonaparte, a bluish-grey bat, with narrow, hairy, interfemoral membrane and elongated backward pointing, falcate tragus; *M. dasycneme* of Boie (see page 157); and the Mediterranean *M. oxygnathus* (Monticelli).

The **generic characters** are slender, delicate form, long tail, hairy face, narrow ear, and tapering, straight, or recurved tragus, combined with variable size.

The muzzle is long, the forehead not prominent, the face hairy, the glandular prominences being much less developed than in *Nyctalus*, *Pipistrellus*, or *Vespertilio*, and scarcely add-

ing to the breadth of the face. The nostril opens without prolongation sub-laterally, the aperture being crescentic.

The **ear** (Fig. 2, Nos. 5-8, p. 7) is long and oval, distinctly longer than broad; the outer margin terminates anteriorly below the base of the tragus, or very slightly in front of it, and does not run forward towards the angle of the mouth; the internal basal lobe is angular. A number of cross-folds or pleats running horizontally across the ear, near the outer margin, are characteristic of the various species, but are often inconspicuous after death. The tragus is long, narrow, and generally attenuated to a point.

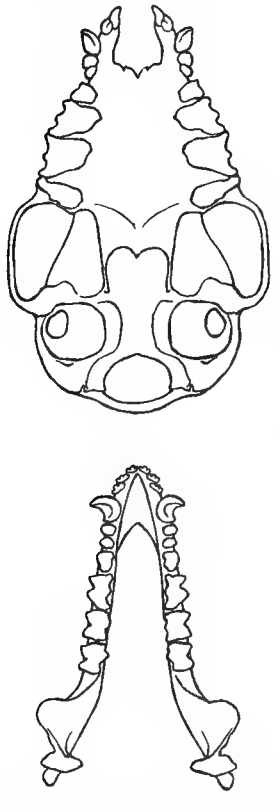


FIG. 13.—DIAGRAM OF ARRANGEMENT OF TEETH IN GENUS *Myotis*.

(1) Upper and (2) Lower Jaw.

The foot, lower leg, and calcar are of variable size and development.

The **wing** is broad, or moderately so, the fifth metacarpal being slightly longer than or about equal to the third; the attachment may be from a little above the ankle, to the base of the toes. The post-calcarial lobe is poorly developed. The tail is rarely so long as the combined head and body.

The **skull** varies in strength according to the size of the species: it has usually a rounded brain-case, elevated above the facial region, which is narrow, depressed, and markedly saddle-shaped: the premaxillary gap is developed to a degree about intermediate between that of *Nyctalus* and *Vespertilio;* the zygomata are flattened, the auditory bullæ moderately developed.

The number of **teeth** (Figs. 8, p. 101, 13, and 16, p. 174) is increased to thirty-eight by the addition of a third premolar in each jaw and side, so that the formula is—

$$i\frac{2-2}{3-3},\quad c\frac{1-1}{1-1},\quad pm\frac{3-3}{3-3},\quad m\frac{3-3}{3-3}=38.$$

The upper incisors are sub-equal, their points generally diver-

gent, the outer slightly outwards, the inner inwards. The two anterior upper premolars are small, especially the central, which is often minute and crowded out of the tooth row internally. The last upper molar is rather less in section than half the second. The lower outer incisors are much larger than the inner. The lower premolars follow the relative proportions of the three upper, but the central, although the smallest, is rarely so minute as the corresponding tooth in the upper jaw.

Group *Leuconöe*:—*Myotis*, as shown in extra-British species, forms an unwieldy and heterogeneous assemblage, which is certain to be subdivided as the relationships of the bats included within it become better known.

The first subdivision to suggest itself is that of which *M. daubentoni* is the sole British representative, and the members of which are characterised by their large feet. This character in *daubentoni*, sufficiently evident as it is, reaches an extreme of development in *ricketi* of Thomas. For these bats the name *Leuconöe*, first used by Boie in 1830, is conveniently available, but, unfortunately, the sharp definition of the group is destroyed by certain exotic intergrading forms, and thus cannot be upheld on careful analysis of the dimensions even of British species alone. The small ciliated interfemoral of *M. nattereri* is a more distinct character.

DAUBENTON'S, OR THE WATER BAT.

MYOTIS DAUBENTONI (Kuhl).

1819. VESPERTILIO DAUBENTONI, Heinrich Kuhl, *Neue Ann. der Wetterauischen Gesellschaft für die gesammte Naturkunde*, i., ii., 195, pl. xxv., fig. 2; described from Leisler's MSS. from Hanau, Germany; Bell (ed. 1); MacGillivray; Blasius; Clermont; Fatio; Bell (ed. 2); Dobson; Blanford; Flower and Lydekker; Lydekker.

1828. VESPERTILIO EMARGINATUS, John Fleming, *British Animals*, 6; Jenyns; not *V. emarginatus* of Geoffroy.

1830. LEUCONÖE DAUBENTONI, Friedrich Boie, Oken's *Isis* (Jena), 256-257.

1839. VESPERTILIO ÆDILIS, Leonard Jenyns, *Ann. Nat. Hist.*, iii., 73, pl. iii., April; described from an albinic variety, from Auckland St Andrew, Durham, England.

1840? VESPERTILIO VOLGENSIS (? species), Eduardo Eversmann, *Bull. Soc. Impériale des Nat. de Moscou*, i., 24; described from Des Kasanischen und Nisch nigorodischen Gouvernment, und im Uralgebirge; placed here by Dobson, 1878.

1844. VESPERTILIO PELLUCENS, J. Crespon, *Faune Méridionale*, 1, 16; *vide* Trouessart, *Bull. de la Soc. d'Étude des Sci. Nat. de Nîmes*, 7, i., 35-39, 1879; described from Nîmes, France.

1855. VESPERTILIO DAUBENTONII, var. EMARGINATUS, G. B. Buckton, *Proc. Linnean Soc.* (London), 6th Dec. 1853, 260.

1856. BRACHYOTUS DAUBENTONII, F. A. Kolenati, *Allgemeine deutsche Naturhist. Zeitung* (Dresden), Neue Folge, ii., 131, 175-176.

1887. MYOTIS CILIATA,[1] J. Daday, *Értekezések a Természettudományok Köréböla* (Budapest), xvi., 7, 35, 1886; not *Vespertilio ciliatus* of Blasius, *vide* Méhely, 330.

1898. MYOTIS DAUBENTONI, Oldfield Thomas, *Zoologist*, 100; Collett; Johnston; Méhely; Cabrera; Millais.

1910. MYOTIS (LEUCONÖE) DAUBENTONI, E.-L. Trouessart, *Faune des Mammifères d'Europe*, 27.

Die Wasserfledermaus of German writers, a book-name merely, there being probably no **local names** for the lesser-known small bats either in Britain or elsewhere.

Distribution:—This Water Bat, or very close allies, attains a comparatively northern latitude throughout boreal and transitional Europe and Asia, ranging from south Sweden and Norway (Collett), Finland, and middle Russia, to Sardinia, Sicily, and Galilee (Tristram); and from Ireland to the Altai, and south to Tenasserim (Dobson). It reaches at least 2000 feet in the Hartz Mountains, and 4000 feet in the Alps. It is not mentioned by Cabrera as occurring in Spain.

It is probably an abundant species in every part of **England** and **Wales**, affording suitable combinations of water and woods. There exist reliable records of its occurrence in every county of England except Wiltshire, Somerset, Gloucester, Buckingham (doubtfully), Huntingdon, Rutland, Nottingham; but, inasmuch as each of these counties is bordered by others in which the bat is well known, there can be little doubt that it will be found in all of them. It ascends to at least 1000 feet, having been observed by Oldham in the ornamental gardens at Buxton, Derbyshire, at that elevation. Its presence in Wight, long ago reported by Bury (see More, *Zoologist*, 1894, 148), is now confirmed by Wadham.

In **Wales** it is definitely known only from Carnarvon, Denbigh, Flint, Merioneth and Montgomery (Forrest). But it is common in several at least of its known haunts, and since the discovery of these is chiefly due to the recent work of Caton Haigh, Oldham, and Forrest, no doubt further exploration will reveal its presence in the remaining counties.

In **Scotland** it is reported from the mainland as widely distributed, although local (Alston), and it occurs at least as far north as Fochabers, in Banff, whence a colony was reported in 1892 (Eagle Clarke, *Ann. Scott. Nat. Hist.*, 1892, 266). In parts of Aberdeen Sim found it

[1] *Vespertilio capucinellus* and *Vespertilio minutillus* are cited under this species as of "Koch, *Bayr. Fauna*," but I cannot find the original reference; see Fitzinger, *Sitzungsberichte der Kaiserlichen Acad. der Wissenschaften* (Vienna), lxiii., 1, 206.

"by far the most common and abundant Bat"; and in Elgin it is not uncommon in some parts of the valley of the Spey (Kinnear); and it may be expected further north. A colony has been recorded from Kinlochaline Castle, Morven, Argyll (Charles Campbell, *Field*, 31st July 1897, 222); it was found abundantly in Perth by Grieve (*Ann. Scott. Nat. Hist.*, October 1894, 193-195), and in Solway is commoner than *P. pipistrellus* (Service), but definite records are still needed for many counties. In the Highlands it reaches at least 512 feet above sea-level (Grieve).

In **Ireland** the bat is as yet but little known. The first known specimen, obtained in Londonderry, was submitted to Jenyns for identification by the Ordnance Collectors (Thompson), the date being given by Jameson as 1838 (*Irish Naturalist*, 1897, 39). It was next encountered by J. R. Kinahan in Kildare in 1853, and was at first identified with *M. nattereri* (*Nat. Hist. Review* (Dublin), i., 23-25 and 87, 1854), but assigned by Bell to the present species (*op. cit.*, i., 148-149; also vi., 383, 1859). Subsequently Jameson (*Irish Naturalist*, *loc. cit.*, also 1896, 94) secured specimens in both counties Fermanagh and Louth; in the former case in Bohoe Cave, in the latter at Branganstown on the river Glyde. Barrington received one from the Lucifer Shoals Lightship, nine miles off the Wexford coast (see below, p. 153). It had been caught on 21st April "flying low over the deck," at 7.30 P.M. Lastly, E. B. Knox sent one to Alcock from Bray, Co. Wicklow (*Irish Naturalist*, 1898, 256). No other reputable records exist, that given by Knox in his *History of Down* being unsupported by evidence, and that by Lydekker for Donegal having apparently been copied from Bell, in whose second edition Thompson's Londonderry record is credited to Donegal. The species thus ranges from north to south of the island, and, since it was found numerously in its Kildare, Fermanagh, and Louth localities, and was established in a distinct colony when found in Wicklow, there can be no doubt that our knowledge of its distribution is defective, and it may yet prove to be a widely spread and abundant species.

Distribution in time:—Bones from the Pleistocene deposits of Ightham Fissure, Kent, have been provisionally associated with this species, or with *Myotis mystacinus*, by E. T. Newton (*Quart. Journ. Geol. Soc.*, August 1899, 420; see also Abbot, *Journ. cit.*, May 1894, 171-211), as have leg-bones from superficial deposits in the caves of Co. Clare, Ireland (Scharff, *Trans. Roy. Irish Acad.*, Feb. 1906, 53); but, in the absence of skulls, it were well to accept the identifications with caution, and in the latter case, as Scharff points out, no conclusions affecting the age of this bat in Ireland can be based on such fresh remains.

The period of gestation is unknown, but probably does not differ widely from that of *Pipistrellus pipistrellus*.

Breeding season and **number of young**:—A single young one is born, most frequently in June and July.

Description:—In general form and appearance this bat is typical of the group *Leuconöe*. In size it is somewhat larger than *Pipistrellus pipistrellus*, but distinctly smaller than *Nyctalus leisleri*.

The **ear** (Fig. 2, No. 5, p. 7), when laid forward, reaches about to the nostril; the outer margin is very slightly notched, the upper two-thirds being straight or only slightly concave, the lower third abruptly convex; a deep emargination opposite the base of the tragus gives rise to a distinctly rounded basal lobe; the inner margin is convex almost throughout its length, most markedly at its centre, whence it passes upwards to a broadly rounded tip; there are four cross-folds.

The tragus, which is about half as long as the ear, reaches its greatest breadth at about its centre, is straight, and not sickle-shaped, and tapers to a more or less acute point; the inner margin is about straight, the outer gently convex, with a distinctly rounded triangular lobe projecting just above the base.

In the **wing** (Plate VII., Fig. 3, p. 86) the most noticeable features are the extremely long lower leg and large foot; a well-developed spur or calcar extends fully three-quarters of the distance from the ankle to the tail, the tip of the spur projecting from the posterior border of the interfemoral membrane as a small, but distinct, lobe. The third digit is short, so that the wing as a whole is of less than average length. The wing-breadth is moderate, the fifth metacarpal being distinctly shorter than the third. The tail is short, and has usually two free vertebræ.

The **fur** is short, but soft and plentiful. The hairs on the ear are small and inconspicuous. The face is half-naked and rather tumid before the nostrils, but the muzzle carries a moustache composed of numerous long hairs (Plate XI., Fig. 2, p. 140). Both surfaces of the wing are furred as far as a line running from the centre of the humerus to slightly below the head of the lower leg; the upper surface and the posterior border of the interfemoral are ciliated, the latter inconspicuously. The toes are provided with whitish hairs.

The **colour** above is warm brown, of some shade between "mars brown" and "mummy brown," the bases of the hairs darker and the tips lighter, resulting in a grizzled appearance; below, near light "broccoli brown," the hairs plentifully tipped with dirty white, or yellowish. The line of demarcation is moderately distinct, and runs approximately from the angle of the mouth to the thigh. The wing is dusky, with a reddish tinge, the interfemoral membrane whitish beneath.

I have had no series from which to study **variation**, seasonal or otherwise, but the general colour is somewhat variable, perhaps owing to age; the young are sometimes described as darker (Bell, Millais), sometimes as greyer (Coward and Oldham). Jenyns' description of *Vespertilio ædilis* was based on an albino specimen.

In the **skull** (Fig. 8, No. 2, p. 101) the profile of the cranium is almost

horizontal; that of the face descends in a slightly concave line at an angle of about 15°. The upper incisors are about equal in size: they are short and broad (Fig. 14), the breadth of the crowns about equal to their length, bicuspid, and with the cusps strongly divergent. The two anterior upper premolars are both in the tooth-row, but the central, which is much the smaller, is slightly displaced internally; its conical tip reaches about to the cingulum of the posterior. The lower outer incisors are oval in section, being about one and a half times as long as they are broad, and less than half as thick as the canines.

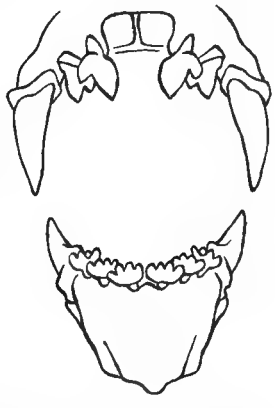


FIG. 14.—FRONT VIEW OF INCISORS AND CANINES OF *Myotis daubentoni* (enlarged and diagrammatic).

Geographical variation has not been worked out in this species, but there is little doubt that had *M. carissima* of North America been taken in England, it would have passed muster as *daubentoni*.

Dimensions in millimetres (see page 148).

Proportionate lengths (males):—Foot, without claws, about ·58 of lower leg; fifth metacarpal, about ·94 of third; lower leg, about ·44 of forearm and about ·33 of head and body.

Skull:—Greatest length, 14·5; basal length in middle line, 11; palatal length in middle line, 6; from posterior border of m^3 to anterior border of canine, about 5; same in lower jaw; greatest breadth at zygoma, 9; posterior breadth, 7·5; breadth between orbits, 7·25; breadth at constriction, 4.

The **weight** is given by Couch (*Zoologist*, 1853, 3942) as 97 grains = 6·44 grammes. The same writer (p. 4012) measured one having an expanse of 10·5 inches = 251·20 mm.

Distinguishing characters:—Of preceding species, the Pipistrelle, which is slightly smaller, can alone be confused with this bat. But the pointed ears; lanceolate tragus; little developed post-calcarial lobe; light under side; large foot, lower leg and calcar; and grizzled upper surface, are quite distinctive.

Daubenton's Bat, although one of the most abundant and characteristic of British mammals, remained for long unrecognised in this country, and affords a striking instance of the light thrown upon our smaller species by the more exact studies of the last years of the nineteenth century. It was first made known to science by the labours of Leisler and Kuhl in Germany. In England, Bingley, who had certainly observed it in its well-

DIMENSIONS IN MILLIMETRES:—

	Head and body.	Ear, greatest length.	Tragus, greatest length.	Tail.	Lower leg.	Hind foot, without claws.	Forearm.	Thumb and claw.	Longest digit.	Metacarpal III.	Metacarpal V.	Greatest expanse of wings.
Males.												
Male (from spirit), Northampton	..	..	..	..	17	9	37·5	5	57	31	29·5	..
Male, Middlesex	..	..		..	17·5	8	38	6	58	32	30	..
Male (from spirit), Temple Combe, England, Oct. 1907	50·4	12·6	6	30·6	15	9	35·6	7	59	32	29·2	244
*Male, Merioneth, Wales, 31st March, 1891	41	12·5	6·75	35·5	..		33	..	..	..	..	202
*Male, Strathspey, Scotland, 5th Sept. 1891	43	9·5	7	36	17	11†	36	..	..	..	..	226
*Male, Loch Dochart, W. Perth, Scotland, 25th July 1894	46	12·5	7·4	35	17	7·5	38	..	..	..	..	227
*Male, do., 25th July 1894	46	14·25	7·4	33·5	15·75	8	37	..	..	..	..	226
*Male, do., 15th July 1894	43	14·25	6·4	37	16	10·5†	38	..	..	..	..	228
*Male, do.	43	14·25	5·8	37	16·5	10†	38	..	..	..	..	227
*Male, do., 15th July 1894	49·5	17·5	6·4	31·5	..	10†	34·25	..	..	..	..	201
Male, Bohoe Cave, Fermanagh, Ireland, 11th July 1895 (Dublin Museum), from dried skin	..	..	..	26	15	10·25	35	5·5	57	31	30	..
Male, Co. Louth, 6th July 1895 (Dublin Museum), from dried skin	..		..	31	15	10	34·25	5·5	60·5	32	30	..
Two males (from spirit), Bohoe Cave, Fermanagh, Ireland (Dublin Museum)	44	..	..	30	18	10·25	38·5	7	64	34	32	..
	46	..	..	..	17·5	9	37	7	60	32	30	
Average of males	49·1	13·4	6·6	32·7	16·3	9·5	36·4	6·1	58·8	32	30·3	222·5
Females.												
Female, Yorkshire, measured by A. Whitaker	43	..	..	34	..	..	..	..	..	..	..	227
Female, Cheshire, 29th June 1897 (dried skin at British Museum)	50	12	..	31	..	9	35·5	..	..	..	..	..
Female, do. do.	51	13	..	35	..	10	35	..	..	..	.	..
Female, Hampshire (measured from spirit at British Museum)	..	..	..	..	17	9	33	6	63	34	31·5	..
*Female, Gordon Castle, N.-W. Banff, 14th July 1892	45·5	13	6·5	37	16·5	8·5	36	10·5	..	..	..	227
*Female, Loch Dochart, W. Perth, 15th July 1894	44	13	6·5	37	16·75	10·5†	39	..	..	..	..	227
Average of females	46·7	12·7	..	34·8		9·4	36·7	..	..	..	..	
*Female, Yorkshire, one day old (A. Whitaker)	29·25	..	..	15·75	..	..	..	..	.	..	76	82 approx.
*Female, Loch Dochart, W. Perth, young, 15th July 1894	29	..	..	18·5	9·5	8·5	18·5	..	..	..	140	101

* Measured by Eagle Clarke in inches, and converted to mm. † With claw.



WINGS ($\frac{1}{2}$ natural size and diagrammatic) OF

1. *Nyctalus noctula.* 2. *Vespertilio serotinus.*
3. *Rhinolophus ferrum-equinum.*

known haunt at Christchurch, Hampshire, and who describes its flight with accuracy, was not aware of its distinctness from the Pipistrelle, and the same remark is probably true also of Gilbert White,[1] who once met with "myriads of bats" on the Thames between Richmond and Sunbury. Fleming, who obtained it in Fifeshire, and Jenyns, who procured one from Milton Park, Northamptonshire, supposed that they had before them the Notch-eared Bat,[2] a species said by its describer to have been obtained near Dover by A. Brongniart, while an albinic example from Durham was believed to be a new species[3] by Jenyns. Yarrell possessed three taken at Islington, and it was from a study of these, together with others belonging to Jenyns, that Bell was led to add the present species definitely to the British list. Yet the Water Bat was for years regarded as one of the rarest of British Chiroptera, whereas we now know it to be, in its own peculiar haunts, one of the commonest and most widely distributed of them all; indeed, the late R. F. Tomes wrote that at certain spots on the Avon, near Stratford, there could not have been fewer than one to every square yard, and this abundance extended over a very considerable space.

So peculiar are the vespertinal habits of this species, that although it is locally abundant, an ordinary observer may be quite unconscious of its existence. It is essentially aquatic, if such an expression be applicable to an animal which never enters the water. It haunts that element continually, flying so close to it that it is difficult to distinguish between the creature itself and its reflection. The flight, quivering and slow, is performed by very slight but rapid strokes of the wings; it may, indeed, be said to vibrate, rather than to fly, over the water. It could not well fly in any other manner so near the surface without often striking it, and this it seldom, or perhaps never, does, although it often pauses to dip its nose into the liquid, whether to drink or to pick up some floating food, has never been ascertained with certainty. Mr G. H. Caton Haigh,[4] however, was on one occasion so for-

[1] Letter xi. to Pennant, dated 9th Sept. 1767, original edit., 1789, 32.
[2] *V. emarginatus* of Geoffroy. [3] *Vespertilio ædilis.*
[4] *Zoologist*, 1889, 434.

tunate as to observe one, after hovering repeatedly over a particular spot, suddenly drop flat with its wings fully extended. There it remained motionless for several seconds, and then rose with apparent ease to continue its flight; the action appeared to be voluntary, and not the result of accident.

The flight of the Water Bat, as it pursues the tenour of its untiring way in easy circles, now over mid-water, now close to the bank, has excited the wondering admiration of many naturalists, and has been by Macpherson compared with that of a sandpiper, and by others with that of a swallow or martin. Its preference for certain areas of streams or lakes to the exclusion of others has, however, hidden it from many eyes, and, although it may be abundant in certain haunts, it is often absent from the surrounding and less favoured localities. Broadly speaking, although with conspicuous exceptions, it prefers pools or reaches where the current is slack or the water stagnant, and where there is ample shelter. One such resort was known to Tomes, near Alcester, in Worcestershire. A small stream called the Arrow passes near the mansion of Coughton Court, and in the grounds is a chain of deep and melancholy ponds overhung by alders and other moisture-loving trees. Here Tomes found the bats abounding. Their diurnal retreat was the roof-chamber of a neighbouring out-building, where the floor was covered an inch or two thick with the evidences of the presence of a numerous colony, and where every crevice overhead was crammed with occupants.

Its peculiar habits occasionally bring this bat under the notice of anglers, and it is probable that many of the accounts of the hooking of bats by artificial flies refer to it. Mr Gordon Dalgleish[1] was successful in securing one with a specially designed bait of tissue-paper, but Mr Symington Grieve found that at Loch Dochart, although several dashed after the artificial flies, they discovered the true nature of the lure in time to save themselves, although he was assured that such was not always the case.

[1] *Zoologist*, 1904, 345; see also F. Coburn, *Journ. cit.*, 1892, 485, the bats being caught by the mouth. In some cases the hook catches in a wing, as related of a Long-eared Bat by C. G. Gray, *Field*, 28th May 1892, 810, the capture being probably not accidental, but due to the bat's having attempted to envelop the bait with its wings.

It does not appear that any study has ever been attempted of the food of this species, but Mr Robert Service[1] believes that it feeds entirely on caddis flies. Judging from the reluctance of captive specimens to attack large insects, not excepting the succulent mealworm, Mr Arthur Whitaker suggests that its ordinary food must be of minute size. Mr Charles Oldham's experience is different, since he found that both mealworms and large moths were accepted without the slightest reluctance. The struggles of the former were overcome without any difficulty, the bat being both bigger and stronger than either the Whiskered or the Pipistrelle. Large and powerful moths were, however, pouched with such promptness and efficiency as to suggest that insects of considerable size are occasionally at any rate captured under natural conditions.

During the day the Water Bat resorts indiscriminately to buildings, trees, or caves, in which its habit is to congregate in hanging clusters, somewhat like swarms of bees, but where there are nooks or crannies in its retreat it wedges itself into them on a system which can only be based upon the utmost economy of space. These colonies, at least in summer, include both sexes, as Mr J. G. Millais found to be the case in two assemblages from which he received specimens in June. Mr T. A. Coward, too, finds the summer colonies composed of both sexes, young and old. It should be noted, however, that five specimens taken by Mr H. Lyster Jameson,[2] on 11th July, in Bohoe Cave, Fermanagh, were all (perhaps only by a coincidence) males.

The diurnal retreats are often, but not necessarily, situated in the immediate neighbourhood of water, and it is no doubt for the convenience thus afforded that this bat loves districts where the woods grow close to the water's edge. It does not object to the companionship of other species, and J. R. Kinahan[3] found it in company with the Pipistrelle in crevices in Tankardstown Bridge, on the river Barrow, Ireland, in 1853. The stones at the entrance were so smooth and

[1] *Ann. Scott. Nat. Hist.*, 1896, 201. [2] *Irish Naturalist*, 1896, 94.

[3] *Proc. Dublin Nat. Hist. Soc.*, Dec. 9, 1853, reported in *Nat. Hist. Review* (Dublin), i., 1854, 23-25; *Zoologist*, 1853, 4012-4013.

polished as to indicate a large colony, and the little animals voiced their protests by a loud outcry, described as chirping, squeaking, and clicking. It was perfectly possible to distinguish the two bats, "both on the wing and when coming out of the hole—Daubenton's coming to its mouth, and thence flying straight out; whilst the Pipistrelle crept to the edge of the pier, and letting himself fall from thence, flew off. This, added to the latter's being more wary and active in dodging the net, rendered him more difficult to capture, and to retain when captured, as out of three, supposed to be of this species captured, I was only able to retain one. Daubenton's Bat does not fly as rapidly nor make such quick turns as the Pipistrelle, and when struck into the water, floundered in it so as to enable me to catch him, while the Pipistrelle, under similar circumstances, just touched it and was off. The cry of the Pipistrelle is much shriller than that of the other. There was also an unmistakably fetid odour from the Pipistrelle, which I did not remark from Daubenton's Bat. . . . On confinement, their manners are very different; the Pipistrelle being impatient, squealing, and biting like a little fury, and running up and down the sides of the net; while Daubenton's Bat was gentle, submitting to be handled, merely gaping with its mouth, and uttering a soft, low chirp; . . ."[1]

One of the most picturesque summer breeding colonies of bats in the British Isles is that described by Mr Grieve,[2] as discovered by him at Glen Dochart, Perthshire. Here the spurs of Creag Liuragam descend at several points in precipitous rocks into the waters of Lochs Ure and Dochart, and in these perpendicular and fissured faces are the chosen homes of Daubenton's Bat. So numerous are they that their presence was in one case detected by the "strange wail" of their voices, which, rising and falling intermittently, attracted attention from the opposite side of the loch, about three hundred yards away.

As is the case with so many other species, the Water Bat often changes its domicile for the winter, at which season

[1] In the quotation, Daubenton's has throughout been substituted for Natterer's Bat, for which species Kinahan mistook it (see p. 145, under "Distribution").

[2] *Ann. Scott. Nat. Hist.*, 1894, 193-195.



SEROTINE BAT. (Natural size.)

it seems to prefer the greater security afforded by a cave or building to the somewhat uncertain protection of the branches of trees, or of open rock-fissures like those of Loch Dochart, which were deserted by their occupants in autumn.[1] In its winter retreats, in contradiction to the sociability of summer, it is not unusually met with hanging singly in complete darkness. Mr Heatley Noble's cavern at Henley-on-Thames, and the mine tunnels at Alderley Edge, Cheshire, are said to be only resorted to in winter.

Possibly the seasonal migration suggested above may at times reach a somewhat extended scale; otherwise, unless it had a wish to emulate the performances of the petrels, it is difficult to account for the capture of a bat of this species, as related by Mr R. M. Barrington,[2] at the Lucifer Shoals Lightship, nine miles off the coast of Wexford, on 24th April 1891.

As a rule, this species is supposed to be late—distinctly later than the Pipistrelle—in making its vespertinal appearance, and to delay the commencement of its flight until the shades of night are well advanced. It is further usually assumed that on emerging it flies straight to the water; but observations on these points are rarely recorded, since it is difficult to detect a bat actually issuing from its retreat. The probable truth is that it is an early flier, but that it begins the evening with some evolutions in mid-air, as has been independently suggested by Messrs Coward and Lyster Jameson.[3] The latter naturalist, at Branganstown, Ireland, and Kinahan, at Tankardstown Bridge, found the Pipistrelle the later of the two, at Tankardstown Bridge by a full half-hour. Lastly, Mr Oldham writes me that, although the average time of appearance at the water in Cheshire is fifty-six minutes after sunset, he has actually caught four bats as they emerged from their den thirty-four and twenty-nine minutes earlier. At the same place, and nearly, although not exactly, at the same date, he caught a Pipistrelle as it emerged some thirty minutes after the Water Bats. The point is one of some interest, and deserves attention.

[1] *Ann. Scott. Nat. Hist.*, 1896, 57-58.
[2] *The Migration of Birds*, 284: R. H. Porter, London, 1900.
[3] *Irish Naturalist*, 1897, 39.

The average time of appearance at the water, as computed by Mr Oldham, for Cheshire, is corroborated for Ireland by Dr N. H. Alcock,[1] who gives it as fifty-four minutes after sunset. At Tankardstown Bridge, Kinahan states that bats began to leave their den at 9.30 P.M. in the last week of June—that is, at about seventy minutes after sunset. In July mornings, also in Ireland, Mr C. B. Moffat found them flying frequently up to forty-four minutes before sunrise, less frequently after that time, and disappearing altogether six minutes later.

That Daubenton's Bat continues its flight all night, although known to Mr Service[2] and others, was first demonstrated by Mr Moffat,[3] who, by many painstaking vigils, has been able to detect its flight before sunrise,[4] as well as after sunset, and at most of the intervening hours, a feat of no easy accomplishment considering the size of the bat and the nature of its haunts.

In spite of its apparent objection to light, this bat has, like others, been observed on the wing by daylight, and William Borrer[5] states, not, however, from his own knowledge, that in the boathouses of Ullswater and Grasmere it flies throughout the day. Cold or wet nights may cause it to suspend its flights altogether, although Mr Coward tells me that it does not object to slight rain. Kinahan found it returning before bad weather at 10 o'clock; and on a wet and stormy 25th June, only one bat issued from the stronghold, in which, at 10.30 P.M., all was quiet, and there was no sign of animation.

Very little is known with certainty concerning the length of the hibernatory sleep, but it appears that roughly speaking it lasts from the latter part of September to the middle of April. Mr Oldham finds the bat active in Cheshire up to 23rd September, and in Hertfordshire to 13th October, while in Ireland it has come under the notice of Mr E. B. Knox, in County Cavan, on the same day, and of Dr Alcock on 26th September.[6] Mr J. Steele Elliott gives the earliest date for its spring appearance at Sutton Coldfield, near Birmingham, as

[1] *Irish Naturalist*, 1899, 31 and 124. [2] *Op. cit.*, 202.

[3] *Irish Naturalist*, 1905, 106-107.

[4] Oldham has seen it flying at 2.45 A.M., or seventy-five minutes before sunrise, on 13th July.

[5] *Zoologist*, 1874, 4128. [6] *Irish Naturalist*, 1899, 33.

27th April.[1] Mr Oldham tells me that he has seen it on the wing in Cheshire on the 19th, and Mr Barrington's Lucifer Shoals specimen was caught on the 21st of the same month. Mr Moffat finds it abroad in Ireland at least from 29th March to 29th October, on one occasion with a temperature so low as 42° Fahrenheit, and, judging from its northern distribution in continental Europe, the bat ought to be at least as hardy as the Pipistrelle; in fact, fæcal matter was found by Mr Oldham in the intestines of one taken at Alderley Edge, Cheshire, on 5th December 1894.

All observers agree that when on the wing this species is silent, but it uses its voice freely for some little time before commencing its evening flight, or when annoyed. Mr Caton Haigh[2] writes of its notes as "very weak and shrill, sometimes prolonged into a sort of chatter." Mr Oldfield Thomas thinks them of particularly high tone, while Mr Whitaker noticed of a newly born one that its utterances were very soft and musical, so faint that they were hardly audible at a distance of a foot.

Daubenton's Bat, like others of its genus, is not known to produce more than one young one at a birth, and it were well to have confirmation of Monsieur Henri Gadeau de Kerville's statement, that the number is even rarely two.[3] The earliest young are probably born in June, the latest in July. Kinahan states that one of the females taken at Tankardstown Bridge in the last week of June contained a large embryo. He makes no mention of the other females taken at the same time, so that we are left to suppose that either they were not examined, or that their young had already been born. Mr F. Coburn[4] took a large embryo almost ready for birth from the body of a female taken on 14th June. Mr Whitaker had a young one born in captivity[5] on the 19th,[6] while Messrs Coward and Oldham, on the 28th, received two fledglings, as well as an adult female, recently a mother.

[1] *Journ. Birmingham Nat. Hist. and Philosoph. Soc.*, Jan. and Feb. 1896, II., i., 7.
[2] *Zoologist*, 1887, 293.
[3] *Faune de la Normandie*, i., 149: Paris, 1888.
[4] *Zoologist*, 1892, 403.
[5] In an instance observed by Professor R. Collett, the mother hung head downwards (*in lit.*).
[6] *Naturalist*, March 1907, 74: unfortunately this bat died almost immediately.

Borrer, Mr William Evans, and Mr Grieve refer to recently born young which they encountered in July, in the last-named instance on the 4th. That mentioned by Borrer was clinging to the nipple of its mother, while Mr Grieve's description of a young one at first hanging on to its mother's back, but afterwards lying rolled up in her left wing, recalls the known habits of the young of other bats.

Although gentle, fearless, and readily taking food, this species is delicate, and seldom lives for long in captivity. A good flight round the room in the evening is, according to Tomes, necessary for its health, whereas the Pipistrelle and the Noctule will live in a box without exercise for a long time, if well supplied with food.

Mr Oldham has remarked that its flight in a room is wavering, uncertain, and much slower than that of the Pipistrelle, the tail is but slightly decurved, and the bat alights frequently on the furniture or pictures. Sooner or later it settles down to the peculiar motions which are so characteristic in a state of nature, skimming the surface of the floor, with typical shuddering or vibratory action, and threading its way amongst the legs of chairs and tables with unerring certainty. Mr Oldham liberated some in a bath-room in the expectation that they would skim over the water in the bath, but they did not do so. One fell into the water, but seemed to be none the worse for the accident, since it paddled along the whole length of the bath, constantly striking the water with its wings on its way.

Captive bats of this species readily drink milk or water, and accept flies, mealworms, and moths, of which Mr Oldham mentions several.[1] Like other bats, they must be taught to eat in their novel surroundings, and a fluttering moth appears to have no meaning for them until it passes close before the face.

As stated above, Mr Oldham finds that the larger moths are pouched in the orthodox manner, the struggle even causing the bat to fall right over on its back. Contrary to Tomes' statement in Bell, not the slightest use was made of

[1] *Xylophasia polyodon*, *Urapteryx sambucata*, *Triphæna pronuba*, *Mamestra brassicæ*, *Cidaria populata*, and *Porthesia auriflua*, the latter accepted with reluctance: *Zoologist*, 1899, 472-473.



1



2



3



4

HEADS (natural size) OF

1. *Myotis mystacinus.*
2. *Myotis daubentoni.*
3. *Myotis nattereri.*
4. *Pipistrellus pipistrellus.*

foot or carpus as a means of securing a firm hold of the prey, and it is possible that on this point Tomes, who certainly did not altogether understand the meaning of the pouching manœuvre, was mistaken, especially as he states that it was not easy to make an accurate observation, from the operation being so much concealed by the body of the animal.

Unlike some other species, Mr Oldham's bats were particularly averse to light, running beneath objects on the table and getting into the shade as much as possible.

Daubenton's Bat is fortunately one of those the identification of which when in its typical haunts is easy. A careful search for it in suitable localities ought to reveal its presence in every county of England and Wales, as well as very widely in Scotland and Ireland. The use of the remarkably large foot is not understood, and is a question well worthy of further study. The suggestion that the bats of this group are cave-dwellers, while the remainder of the genus live mainly in trees,[1] appears to be untenable. They may well be called Water Bats, from their habit of flying over streams, ponds, and lakes in the peculiar manner of the sole British member of the group.

[THE ROUGH-LEGGED WATER BAT.

MYOTIS DASYCNEME (Boie).[2]

The Rough-legged Water Bat was included in the British list by Sir Harry Johnston and Mr Richard Lydekker, although excluded by most other naturalists. Its claim to be considered a British species rests upon the authority of R. F. Tomes,[3] who thus identified a specimen taken upon the banks of the Stour by G. B. Buckton. Buckton[4] himself regarded his specimen as a variety of Daubenton's Bat, and alluded to it under the name *emarginatus*, a name not infrequently applied to that bat by British naturalists of the period. It was probably Buckton's record which caused Dobson[5] to include southern England in the area of distribution of the present

[1] Dobson, *Catalogue of Chiroptera*, 285.
[2] F. Boie, Oken's *Isis* (Jena), 1825, 1200.
[3] *Zoologist*, 1854, 4361 ; 1856, 4938.
[4] *Proc. Linnean Soc.* (London), 1853, 260 (pub. 1855).
[5] *Catalogue of Chiroptera*, 296.

species, but no evidence supporting the statement has ever been printed.

This bat, which is an inhabitant of temperate and boreal Europe and Asia, at least from the shores of the North Sea to the Altais, differs from Daubenton's Water Bat, amongst other characters, in its larger size, smaller central upper premolar, more pointed ear, and forward curving tragus. The forearm measures about 45 millimetres.]

THE WHISKERED BAT.

MYOTIS MYSTACINUS (Kuhl).

1819. VESPERTILIO MYSTACINUS, Heinrich Kuhl, *Neue Ann. der Wetterauischen Gesellschaft für die gesammte Naturkunde*, i., ii., 202; described from Leisler's MSS., from Hanau, Germany; Bell (ed. 1); Jenyns; MacGillivray; Blasius; Clermont; Fatio; Bell (ed. 2); Dobson; Harting, *Zoologist*, 1888, 161-166, pl. 2, and 441, pl. 3; Blanford; Flower and Lydekker; Winge.

1821. VESPERTILIO COLARIS, H. R. Schinz, Cuvier's *Das Thierreich*, i., 177; described from the collared phase (see description below), from Meisner's MSS., from Mont Blanc, Switzerland; type lost, *vide auct. cit.*, *Europäische Fauna*, 17, 1840.

1827. VESPERTILIO SCHINZII, C. L. Brehm, *Ornis* (Jena), iii., 27; described from Renthendorf, Germany.

1833. VESPERTILIO HUMERALIS, L. A. F. Baillon, *Mém. de la Soc. Roy. d'Émulation d'Abbeville*, 50; described from the phase with black shoulder-patches (see description below), from Abbeville, France.

1838. VESPERTILIO EMARGINATUS, William MacGillivray, *British Quadrupeds*, 96; not *V. emarginatus* of Geoffroy.

1841. SELYSIUS MYSTACINUS, C. L., Prince Bonaparte, *Fauna Italica*, i., introduction (3).

1844. VESPERTILIO LATIPENNIS, J. Crespon, *Faune Méridionale*, i., 17; *vide* Trouessart, *Bull. de la Soc. d'Étude des Sci. Nat. de Nîmes*, 7, i., 35-39, 1879: described from Nîmes, France.

1845. VESPERTILIO BRANDTII, Eduardo Eversmann, *Bull. Soc. Impériale des Nats. de Moscou*, xviii., 505, pl. 13, fig. 8, 1845; described from the Samara River, and province of Kasan, S.-E. Russia.

1856. BRACHYOTUS MYSTACINUS, F. A. Kolenati, *Allgemeine deutsche Naturhist. Zeitung* (Dresden), Neue Folge, ii., 131, 174-175; not *Vespertilio ciliatus* of Blasius, 1853 = *V. emarginatus* of Geoffroy.

1862-63. BRACHYOTUS MYSTACINUS, var. NIGRICANS, var. RUFOFUSCUS, and var. AUREUS, Carl Koch, *Jahrbücher des Vereins für Naturkunde im Herzogthum* (Nassau), xviii., 440-448; see also *Zoologische Garten*, xi., 368-9, 1870; described from Nassau, Germany.

1869. VESPERTILIO MYSTACINUS, var. NIGRICANS, Victor Fatio, *Vertébrés de la Suisse*, i., 92; described from Switzerland: see Mottaz, *loc. cit. infra.*

1869. VESPERTILIO LUGUBRIS, *auct. et loc. cit.*; see Mottaz, *Bull. Soc. Zool.* (Geneva), Nov. 15, 1908, 152-153.

1870. VESPERTILIO MYSTACINUS, (1) var. NIGRICANS, (2) var. RUFOFUSCUM, (3) var. AUREUM, Carl Koch, *Zoologische Garten*, xi., 368-369, 1870; all described from three coloured plates, from Frankfort, Germany.

1871. VESPERTILIO MYSTACINUS, NIGRO-FUSCUS, L. J. Fitzinger, *Sitzungsberichte der Kaiserlichen Acad. der Wissenschaften* (Vienna), lxiii., 1, 217; renaming Brehm's *Vespertilio schinzii*.

1871. VESPERTILIO MYSTACINUS SCHRANKII,[1] *auct. et op. cit.*, 219.

1871. MYOTIS BRANDTII, *auct. et op. cit.*, 284.

1898. MYOTIS MYSTACINUS, Oldfield Thomas, *Zoologist*, 100; Collett; Méhely; Johnston; Cabrera; Millais, 99, pl. 12.

1910. MYOTIS (MYOTIS) MYSTACINUS, E.-L. Trouessart, *Faune de Mammifères d'Europe*, 33.

Le Vespertilion Moustac of the French; *die Bartfledermaus* of the Germans; but these are book-names only, the bat being probably unknown to popular observation either in this country or in continental Europe.

Distribution:—This bat, or closely allied representatives, ranges through boreal and transitional Europe and Asia, from sea-level to at least the summit of the Hartz Mountains (Blasius), and in the Alps to about 5500 feet (Fatio), from about 65° N. latitude in Skandinavia (Collett), Finland, and middle Russia to Spain, Syria, and Transcaucasia, where it is very common (Satunin); and from Ireland to Ferghana, the Altais (Kaschtchenko), the Amoor (Schrenck), Pekin (Dobson) and Sakhalin. *M. siligorensis* (Horsfield) of Nepal and Sikkim is, perhaps, sub-specific. The species appears to have no near representative in America.

M. mystacinus is probably a common species in every part of **England**, except portions of the east and possibly the north. But it is so little known and so often confused with *Pipistrellus pipistrellus* that the information at our disposal is still very meagre. It was until recently regarded as rare or unknown in many localities where it has since been ascertained to be plentiful. In Yorkshire, for instance, the first record dates from 1882 (Roebuck, *Zoologist*, 1882, 147), yet six years later Roebuck described it as "one of our common species," about equally common with *Plecotus auritus* and *Pipistrellus pipistrellus* (*Journ. cit.*, 1888, 164-165). Similarly, Oldham's Shropshire record of 1890 (*Journ. cit.*, 1890, 349) was, I believe, the first, but Forrest now writes me that he has since received many examples from all parts of that shire. Remembering these facts, and its occurrence far to the north in Sweden and Finland, it seems reasonable to suppose that the regular range of *M. mystacinus* extends northwards in Britain, at least to the Highlands.

[1] A. Wagner (Wiegmann's *Archiv für Naturgeschichte*, ix., 25, 1843) mentions *V. schrankii* as of Koch, but I cannot find the original description.

To come to details; in spite of scarcity of information, Harting, who collected the available data up to 1888 (*Zoologist*, 1888, 161-166), was able to cite occurrences in Somerset, Dorset, Hampshire with Wight (see also More, *Journ. cit.*, 1894, 148; Wadham), Sussex, Kent, Essex, Cambridge, Northampton, Warwick, Worcester, Stafford, and one or two other counties (see also Cocks, *Journ. cit.*, 1906, 186) to be more particularly noticed. Millais added Devon, Berkshire, Surrey, and Middlesex, but without details; Aplin, Oxford (*Journ. cit.*, 1901, 315; 1904, 311); Oldham, Derby (*Journ. cit.*, 1889, 68-69), and Lancashire (*Journ. cit.*, 1890, 349); and Clark Cornwall. Many of the above are bare records only, the distribution of the bat not having been worked out; but for a few counties there is more detailed information, as, for instance, for Cheshire and Derby, where Coward and Oldham find it widely distributed; Somerset (see also *Zoologist*, 1907, 193), Gloucester, and Wiltshire, where Jenyns (quoted by Harting) found it commoner than *P. pipistrellus* at Bath, and Charbonnier and Lloyd Morgan report similarly from the district around Bristol; Shropshire as noticed above; Yorkshire, where, as already shown, it is one of the commonest species; and Essex, where Laver, who has seen it wherever he has looked for it, believes it to be much more plentiful than is generally supposed. These records, added to the fact that in **Wales** it has been taken in Carnarvon (Oldham, *Zoologist*, 1896, 255), is probably not uncommon in Denbigh (Oldham, *Journ. cit.*, 1906, 70), is very likely the most abundant bat of Merioneth (Caton Haigh, *Journ. cit.*, 1887, 294), and has a general reputation for being not uncommon in the north of the principality (Caton Haigh, *Journ. cit.*, 1887, 144), probably indicate a wide distribution. But the reports from East Anglia are strangely different, since Jenyns, in contrast to his experience at Bath, comments upon its rarity; and Caton Haigh, Rope, and Southwell have quite failed to find it in Lincoln, Suffolk, or Norfolk. The bat may clearly be regarded as common in all worked counties of England and Wales, except those in the east, to at least as far north as the York and Durham boundary, and the remaining counties will probably be added to the list in due course; they are Hereford, Leicester, Rutland, Buckingham (where Cocks, although unable to produce a specimen, is sure that it occurs), Hertford, Bedford, Huntingdon, Nottingham, Montgomery, Radnor, Brecknock, Cardigan, Pembroke, Carmarthen, Glamorgan, Monmouth, Anglesey, and Flint.

The distribution in the north of England may be treated separately. So far as I know, no records exist for Westmorland or Northumberland; Durham has but one, and that not so satisfactory as might be (see Harting, *op. cit.*, 165), but Macpherson mentions four for Cumberland, including one near the Scottish border.

In **Scotland** this bat has been taken twice—in the first instance by Hardy, on the road to Pitlochry, about four miles from Rannoch, Perth, in June 1874. The specimen, which is in the Owens College Museum, Manchester, long lay unrecorded, but, happening to attract the attention of Kelsall, was by him mentioned to Harting and alluded to by the latter writer (*op. cit.*, 165), a clue which enabled W. Evans to work out its entire history (*Mammalian Fauna, Edinburgh District*, 23-24). For the second record we are again indebted to the activity of Evans, who received from George Pow an example taken at Dunbar, Haddington, on 20th March 1893 (*Ann. Scott. Nat. Hist.*, 1893, 146). No other Scotch specimens are known, Millais' allusion to a third record being an error, so there is as yet no means of estimating the exact status of this species in North Britain.

In **Ireland** the species was first taken by J. R. Kinahan, by whom one, caught by a cat at Treakle, Co. Clare, in August 1852, was presented to the Dublin Natural History Society, in February 1853 (*Nat. Hist. Review* (Dublin), i., 24, 1854; see also, vi., 383, 1859). This was at first recorded as an example of *M. daubentoni*, but the mistake was corrected at a meeting of the same Society on 12th May 1854 (*Nat. Hist. Review* (Dublin), i., 148, 1854). In 1897 (*Irish Naturalist*, 38-39) Jameson was able to add the counties of Fermanagh and Louth as within its habitat, it having been taken in three separate localities within the former county, and being, in his own experience, probably not uncommon in the latter. It has since been detected in Dublin (Welland, *Journ. cit.*, 1898, 272; Alcock, *Journ. cit.*, 1899, 57), including Lambay Island (Baring, *Journ. cit.*, 1907, 19): Down (Lett, *Proc. Belfast Nat. Field Club*, 20th March 1900; R. Patterson, *Irish Naturalist*, 1900, 162): Wexford (Moffat, *Journ. cit.*, 1902, 103; Barrett-Hamilton, *Journ. cit.*, 1908, 207): and Carlow (Pack Beresford, *Journ. cit.*, 1906, 16); in most cases more than once in the same county, a fact which, as in the case of so many other species, seems to indicate defective human knowledge rather than rarity.

M. mystacinus is found in the Yorkshire hills to a height of 1400 feet in the Washburn Valley (Storey, MSS.), and in Cheshire it ascends to heights little inferior in the Longdendale and Goyt Valleys, as I am informed by Coward and Oldham.

Distribution in time:—See under *M. daubentoni*.

The **period of gestation** is unknown, and the **number of young**, in Britain at least, is believed not to exceed one, usually born in June or July.

Description:—The general form and appearance of this bat are those of its genus, exclusive of the group *Leuconöe*, and it is thus readily distinguished from the Pipistrelle, than which it is larger. It is smaller than *M. daubentoni*.

The forehead is elevated, the occiput prominent, the muzzle pointed, the nostril moderately tumid (Plate XI., Fig. 1, p. 140).

The **ear** (Fig. 2, No. 6, p. 7), when laid forward, reaches well beyond the tip of the nose; the outer margin is rather deeply notched, the upper half being deeply concave, with wavy outline, the lower half abruptly convex; a slight emargination opposite the base of the tragus gives rise to a small but distinct basal lobe; the inner margin is convex throughout its length to the rounded tip; at its base it bends inwards almost at right angles to its former course; there are four to six cross-folds.

The tragus (Fig. 2, No. 6, p. 7), which is broadest at a point opposite about one quarter of the height of the inner margin, is straight, does not curve outwards, and tapers to a point at slightly more than half the height of the ear; the inner margin is straight, the outer margin roughly triangular, with a small rounded basal lobe surmounted by a concavity.

The **wing** (Plate XIII., Fig. 1, p. 174) arises from the base of the toes, and, the third and fifth metacarpals being more nearly of equal length, is broader than that of *M. daubentoni*. The relations of the lower leg and foot are remarkably different, the length of the latter being only about half that of the former as against nine-sixteenths in *M. daubentoni*. Relatively to the forearm the lower leg is longer than in any other bat already described, and creates a large interfemoral membrane. The calcar is small, extends along the free border of the interfemoral only about halfway from foot to tail, and does not terminate in a noticeable projection.

The **fur** is long and thick, burying the eyes, covering the face to the upper lips, and giving it a short, thick appearance; the lips are fringed with a moustache of bristles, and there are a few on the chin and a row across the forehead. On the wing, above and below, the fur extends to a line connecting the central points of humerus and femur, and on the interfemoral membrane to the end of the third caudal vertebra above and to the root of the tail beneath. The ear is very sparsely haired.

The **colour** is somewhat variable, but the most frequent type is probably that having the upper surface somewhere between or near grizzled "raw umber" and "wood brown," the lower surface lighter and nearer dirty white. These colours are those of the tips of the hairs, the bases being everywhere dusky. The line of demarcation is not abrupt, and runs approximately from the angle of the mouth to and along the line of attachment of wing and body. The face and chin are often dusky, in contrast to the brownish forehead and whitish throat, and there may be conspicuous patches of dusky hairs at the inset of the arms, a pattern which no doubt suggested the technical names *colaris* and *humeralis*.

The bare skin of the muzzle, face, nose, lips, ear, and limbs, is silky black, the wing and tail brownish black; the nails dusky with paler tips.

The young are darker above and lighter below; but old females,

especially after having reared their young, are said to have the upper side faded or rusty (Bell).

In the **skull** (Fig. 8, No. 3, p. 101) the profile is saddle-shaped, or like a shallow S; the frontal region is depressed, and the narrow muzzle about horizontal. The bullæ are small.

The **teeth** are similar to those of *M. daubentoni*, but the outer lower incisors are not so long in section (Fig. 15).

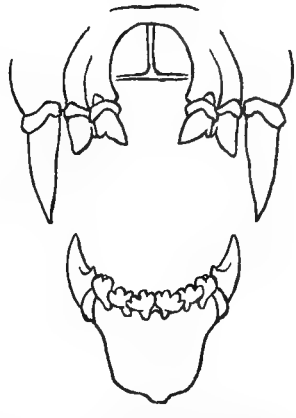


FIG. 15.—FRONT VIEW OF INCISORS AND CANINES OF *Myotis mystacinus* (enlarged and diagrammatic).

Individual variation runs frequently towards melanism, and some specimens give the general impression of being sooty black, but it is not known whether this phrase is due to true melanism, or is merely exhibited at seasons when the brown hair-tips may have worn away. C. Koch (*Zool. Garten*, xi., 1870, 369) and Fatio state that in Germany and Switzerland this form, which they name "*var. nigricans*," is an inhabitant of the mountains; the former distinguishes also two other forms—a "*var. aureum*" from south Germany and the plains, and the typical "*var. rufofuscum*." Probably all three occur in Britain.

Koch mentions also an albinic example, a young male; otherwise, information on the variation of this species is very deficient and demands attention.

The **geographical variation** is also, as yet, unknown, but Blanford states that Nepalese specimens are of large size.

Dimensions in millimetres (see page 164).

Charbonnier and Lloyd Morgan state that newly-born bats of this species have an expanse of about three inches (75 millimetres).

Proportionate lengths:—Foot (without claws) about ·48 of lower leg; fifth metacarpal about ·96 of third; lower leg about ·45 of forearm and about ·34 of head and body.

Skull:—Greatest length, 13·5; basal length in middle line, 10·5; palatal length in middle line, 5·75; from posterior border of m^3 to anterior border of canine, 5; same in lower jaw, 5·5; greatest breadth at zygoma, 8; posterior breadth, 7; breadth between orbits, 6; breadth at constriction, 3·75.

Distinguishing characters:—The Whiskered Bat is most frequently confused with the Pipistrelle, a bat of similar size, from which it differs in many important respects, notably its thirty-eight, not thirty-four, teeth, its hairy face, longer than broad, notched ear, and lanceolate tragus. The forearm, third and fifth metacarpals, and lower leg are

all distinctly longer. Relatively to the forearm, the lower leg, foot, and third metacarpals are longer, but the longest digit is shorter. Daubenton's Bat, on the other hand, is distinctly larger than the Whiskered, and, apart from its shorter, hardly-notched ear, and shorter tragus, broadest at about its centre, is easily marked out by the proportions of its large foot and calcar.

DIMENSIONS IN MILLIMETRES:—

	Head and body.	Ear, greatest length.	Tragus, greatest length.	Tail.	Lower leg.	Hind foot, without claws.	Forearm.	Thumb and claw.	Longest digit.	Metacarpal III.	Metacarpal V.	Greatest expanse of wings.	Weight.
Male (in spirit), Burrington, Cheddar, Jan. 1907	50	..	..	..	18	7·5	37	6·0	55	30	30	..	..
Male, Macclesfield (dry skin in British Museum)	44	11	..	30	14	..	35	..	53	30	28	..	..
Male, Co. Louth, 18th July 1905 (Dublin Museum)	..	..	..	..	..	..	32	..	..	..	..	..	..
Male (in spirit), Co. Fermanagh, 11th July 1895 (Dublin Museum)	42	..	..	31·5	16	7	33	5·25	53·5	28·5	27	..	..
Male, do. (do.) (no date)	..	..	..	..	16·5	7	34	5·25	53·25	28	26·25	..	..
Female, Burrington, Cheddar, Jan. 1907	..	..	..	..	16	7·5	34	5	55	29	27	..	..
Female, Merioneth, 8th July 1892 (W. E. Clarke)	48	14	7·5	35	14	8	33	5·5	..	..	..	228	5·45 grms.
Average (approximate)	46	..	..	..	15·5	7·5	34	5·5	54	29	27·5	..	..
Male, young (in spirit), Burrington, Cheddar, Jan. 1907	48	..	..	..	16	7·5	34	5·5	54	28	26·75	..	..

The Whiskered Bat is probably the commonest British representative of its genus. It was described by the German naturalist Leisler early in last century, and was first recorded as British by J. E. Gray[1] in 1826. Gray supposed that Montagu confused it with the Barbastelle, and stated that the specimen thus named in the British Museum, which belonged to Montagu, was really a Whiskered Bat. The bat was afterwards obtained by Jenyns, Yarrell, and Bell, the latter of whom figured it in his first edition. In Ireland, J. R. Kinahan found it in County Clare in 1853, and it has since been shown to be anything but rare. In fact, in the west of England and Wales it probably outnumbers the

[1] *Zoological Journal*, ii., 109.



WHISKERED BAT. (Natural size.)

Pipistrelle, the popular "Common Bat" of this country generally. It is hardly known in Scotland.

But although not rare in England, the Whiskered Bat is little known and seldom seen, a fact which has given it a reputation for scarcity, or, at least, for solitary habits. It might, indeed, be inferred from the published accounts that it is quite unusual to find it in company, an inference strengthened by the fact that, in its winter retreats, each individual hangs, as a rule, in its own corner or crevice, in marked contrast to the strongly gregarious character of the Noctule and other species, which crowd closely together. On the other hand, assemblages have been described, as by R. F. Tomes,[1] who knew of a colony consisting of more than a hundred, inhabiting the roof of his house at Littleton, Worcestershire, and by Mr Oxley Grabham,[2] who took five from behind a shutter in Yorkshire; and it may be that further examination will prove it to be more sociable than is commonly supposed.

The flight of this bat so closely resembles that of the Pipistrelle that the most acute observers often fail to distinguish the two when on the wing, a fact due rather to their small size, which prevents accurate observation and comparison, rather than to any real resemblance. In the confined space of a room the two are very different, and, apart from the Whiskered Bat being larger, the slow and steady rhythm of its flight, always prone to "skim" floor or ceiling, the interfemoral membrane with a downward curve, is, as in Daubenton's Bat, very characteristic.[3] If there be other distinctions, they lie, perhaps, in the general silence of the present species, the Pipistrelle being very noisy, and its supposed preference for the branches of trees, from the leaves of which it picks off its prey; in fact Tomes thought it the most arboreal of all English bats. According to Mr G. H. Caton Haigh, the Whiskered Bat comes abroad earlier in the evening than the Pipistrelle, "and usually selects for its hunting-ground the sheltered ends of a high hedge or plantation, or even a cliff, along which it flies to and fro, seldom rising as high as the tops of the trees or rocks nearest to it. When crossing an open space it

[1] *Worcestershire*, i., 174. [2] *Naturalist*, 1899, 74.
[3] As remarked also by Caton Haigh, *Zoologist*, 1887, 294.

generally keeps close to the ground." He has never observed this species frequenting the open places in woods, of which the Pipistrelle is very fond. In Worcestershire, Tomes[1] has seen the bats drop out of a hole under the slates of his house, either singly or in twos or threes. They lost no time in getting into the top of a large walnut tree, through which they passed, and scattered off to other trees to feed, passing with quivering flight through the branches and leaves. Other naturalists such as Mr Arthur Whitaker, remark on their preference for the neighbourhood of water, and Mr Charles Oldham has described his observation[2] of at least one hundred feeding along half a mile of the river Dane at Danebridge, near Macclesfield. "Their flight," he writes, "was slow, steady, and silent—I have never heard this species squeak on the wing. Individuals did not appear to wander far, but confined their attentions to single pools or short stretches of the stream, where they flitted about the alder bushes or threaded their way with marvellous precision through the lower branches of the sycamore trees. I never saw one rise to a greater height than twenty feet, and often they flew within a few inches of the ground, or skimmed the surface of a pool for a yard or two, only to rise again and resume their flight around the alders. Even when close to the surface of the river their flight could never be mistaken for the continuous flight at the same level, just above the surface, of the narrow-winged" Water Bat. That this bat may sometimes wander to comparatively exposed situations, is shown by its occurrence—the second time on record for Scotland—on the links east of Dunbar, by the shores of the North Sea, and again on Lambay Island, off the east coast of Ireland. Like that of the Pipistrelle, its flight is often so lowly as to lead to its destruction by means of sticks and caps. One which came under the notice of William Borrer[3] had flown in broad daylight against a man's white frock, white being particularly attractive to bats. Another, which came into the hands of Mr Grabham,[4] had struck against a policeman's helmet in the streets of York, while Mr Oldham[5] found one hanging in a moribund condition impaled upon a

[1] *Worcestershire*, i., 174. [2] *Naturalist*, 1897, 242. [3] *Zoologist*, 1874, 4128.
[4] *Naturalist*, 1899, 74. [5] *Zoologist*, 1899, 475.

briar, a thorn of which, despite its usual agility, it had evidently failed to avoid.

During its season of activity the Whiskered Bat chooses varied situations for its diurnal resting-place, and, as a rule, sleeps apart from its fellows. Holes in walls, in roofs of houses and buildings, and the spaces behind shutters and sign-boards, are its customary home. Less frequently, it resorts to some convenient hole or crevice in a tree, or creeps behind a loose piece of bark. Among more exceptional retreats may be mentioned the ivy on a wall,[1] an auger-hole in an old gate-post,[2] and a crevice between two boulders in a wood;[3] one has even been found asleep in bright sunlight on the top of a stone wall.[4] During the summer months it rarely resorts to caverns and similar situations, although Mr Oldham has taken one near the entrance to an old mine-tunnel in June,[5] but in the winter such places are favourite hibernacula. Messrs T. A. Coward and Oldham have frequently found it at that season in disused copper-mines at Alderley Edge, Cheshire, and in old lead workings in the Derbyshire dales, places which are deserted in spring. Of Alderley they write that: "The red sandstone rock is pierced in many places by horizontal tunnels about six feet high and as much in width. From November to March these tunnels are resorted to by Whiskered, Long-eared, and, more rarely, Daubenton's Bats, which hang suspended by their feet from the roof and walls. We have found all three species in the same tunnel, but they cannot be said to associate with one another, and the individual bats are, with the rare exception of the Long-eared, always solitary. At times a bat may be found near the mouth of a tunnel where there is sufficient light to see it without a candle, but as a rule they retire to the deeper recesses, sometimes more than a hundred yards from the tunnel mouth, where they are in total darkness. For the most part the tunnels are dry, but the bats sometimes hang in damp places, and their fur then glistens with beads of water. It is possible that they feed during their retirement, for, although

[1] *Zoologist*, 1874, 4128. [2] Tomes in Bell.
[3] N. H. Alcock, *Irish Naturalist*, 1898, 272.
[4] W. D. Roebuck, *Naturalist*, 1886, 113. [5] *Zoologist*, 1896, 255.

we have never seen one on the wing, we have often found food in the alimentary canal on dissection, and, indeed, food in abundance is close at hand, as the tunnels are resorted to in winter by a spider, two species of Moth . . .,[1] and myriads of flies.[2] No bats are to be found in these tunnels during the warmer months of the year." In Mr Heatley Noble's big artificial cave near Henley-on-Thames, Mr A. H. Cocks and Dr E. A. Wilson[3] found seven on 14th February, all near one of the entrances, but in summer this cave is deserted by all bats.

The Whiskered Bat is frequently seen abroad during the day, probably more so than any other British species, and it is also one of those which appear on fine days—at least in the south—throughout the winter. Mr C. B. Moffat records it as flying at a temperature of 48° Fahrenheit on 21st January, in Ireland; Borrer[4] received one shot near Dover in the mild January of 1853; Mr William Evans' Dunbar specimen was taken on 20th March, and Mr T. W. Proger sends me word that he has observed it abroad in south Wales on 21st December 1903, and in Wiltshire at the end of November of the same year. But the too frequent confusion of this species with the Pipistrelle makes a series of reliable observations impossible. Little is known about the duration of the nightly flight. Probably, however, it begins early in the evening, Mr Oldham having noticed one on the wing at 7.30 P.M. in broad daylight in the latter end of May:[5] it may also last all night, since I caught one in my house between one and two o'clock on the morning of 26th July.

Only the most vague information is available about the breeding habits of this bat. Tomes' statement that its single young —the number verified by dissection—is brought forth about the end of June or in July, corroborates, as regards the number at least, the experience of Blasius, for Germany. Messrs H. J. Charbonnier and C. Lloyd Morgan[6] found that of some hundreds obtained at Willsbridge, near Kevnsham, Bristol.

[1] *Gonoptera libatrix* and *Scotosia dubitata.*

[2] Of which the most abundant are *Blepharoptera serrata*, *Borborus niger*, and a species of *Culex.*

[3] *Zoologist*, 1906, 186; also, Wilson, in lit. [4] *Zoologist*, 1874, 4128.

[5] *Naturalist*, 1897, 242. [6] Charbonnier, see *Somerset*, i., 164.

on 2nd July, twenty or more examined were all females. Several had young ones clinging to their fur, and others became mothers the next day, the newly born bats being of the usual naked appearance, with dusky heads and wings. An immature male (now preserved in the Dublin Museum) was found clinging to a house by Mr W. Garstin on 18th July, in County Louth, Ireland; another taken at Kilmanock, County Wexford, on 26th July, although immature, had attained the usual size of an adult: both seem to show that the date of birth may be much earlier in Ireland. Allowing seven weeks for gestation and as many more for growth of the young, it may be safe to calculate that the mothers of these two young bats became alert enough to ovulate in the middle of April, and gave birth to their young at the end of May or in the beginning of June.

Mr O. V. Aplin[1] suggests that the Whiskered Bat feeds largely on moths, but the only definite information available on this subject is the statement of Professor G. H. Carpenter,[2] that the fragments of insects in the excreta of an Irish specimen seemed all referable to the two-winged flies.[3] Mr Oldham found a small staphylinid beetle in the mouth of one which he captured.[4]

In captivity, this species has been the subject of study by Dr Alcock[5] and Mr Oldham,[6] the latter of whom has written a detailed account of its habits and demeanour. It appears that, although naturally of fierce temperament when first taken, it may be readily tamed, and when the difficulties at first attending its feeding have been overcome, it displays a marvellous appetite, swallowing with eagerness moths,[7] spiders, and raw rabbit's liver, and lapping up milk or water even more readily. Dr Alcock's specimen also partook of fish, while Mr Oldham's executed an elaborate toilet—a habit common to other species—but, true to the character of its race, it was the host of external parasites, a tick and two fleas having been caught upon its person by its captor.

"It evinced," writes Mr Oldham, "little disposition for

[1] *Zoologist*, 1901, 315; 1904, 311. [2] *Irish Naturalist*, 1902, 103.
[3] *Diptera*, and that some pieces of legs and wings clearly belonged to a small Tipulid—very possibly a species of *Trichocera*.
[4] *Naturalist*, 1897, 242. [5] *Irish Naturalist*, 1899, 56.
[6] *Zoologist*, 1899, 49-53. [7] *Scotosia dubitata* and *Gonoptera libatrix*.

flight, especially after feeding, and if compelled to take wing would, after one or two turns round the room, drop on to the floor, or pitch on a curtain, chair, or my head or body. . . . Although loth to fly, it seemed never tired of running about among the papers and other objects on the table, and was seldom stationary unless it was eating. The bell-jar in which I kept it was raised above a stand on supports rather more than $\frac{1}{4}$ in., or, to be exact, just 7 mm. in height, and whenever the perforated zinc guard was removed from the intervening space the Bat would creep out at once. The bright light of the lamp on my table seemed to cause it no inconvenience, for it used to sit, supported on feet and wrists, eating mealworms within a few inches of the flame, and never showed any desire to retire to dark or shaded places. Sometimes it would creep under my hand, or up my sleeve, but this, I think, was on account of the sensation of warmth it experienced in nestling against my skin.

"The sense of sight seems to be but feeble in the Whiskered Bat. The example under notice could not see, or at all events recognise, a mealworm or wet paint-brush, if more than an inch from its face. As this species is more diurnal than any other British bat, and may frequently be seen abroad at midday in summer, the inability of my captive to see objects an inch away cannot be attributed to the dazzling effects of too strong a light, especially as this inability existed equally in the daytime and in the artificial light of a lamp. Its hearing also appeared to be dull, as it never showed by any movement of its head that it perceived a sudden noise, such as the snapping of my fingers, or the click of a watch-lid being closed. It sometimes slept prone upon the floor with wings folded and pressed closely to its sides, at other times suspended by its toes to the rim of a wooden box. During sleep, which was always profound, its temperature fell considerably, and it felt, as all Bats do in this state, extremely cold. It usually wakened in the evening, but exceptionally in the daytime without being roused; while, as a rule, it was necessary to warm it into activity by holding it for a minute or two in my hand if I wanted to feed it by daylight."

Its voice, often used, is described by Mr Oldham as a feeble squeak, less shrill than that of the Long-eared Bat, and by

Dr Alcock as lower in pitch than that of other species. Frank Norton[1] likened it to the clicking of a cogwheel and chain.

It was in this species that Mr Oldham first observed the habit of pouching the prey[2] already alluded to in the account of the Pipistrelle (see Plate VIII.), and his remarks thereon may fittingly conclude this article. "My captive," he writes, "used to tuck its head away under its body directly it had seized an insect, at the same time bringing its feet forward, so far indeed that it sometimes lost its balance and toppled over on its back. This habit, practised from the very first, was evidently one of old standing, and not a trick acquired in confinement. By feeding the Bat on a sheet of glass so that I could see it from beneath, or, better still, by giving it an insect as it hung suspended by its toes, the reason of its action was at once apparent. The tail being directed forward beneath the body, the interfemoral membrane formed a pouch into which the Bat thrust its head, and was thereby enabled to get a firmer grip of its prey without any danger of dropping it. When the Bat was on a flat surface the lower side of this pouch was pressed closer to its belly than would be the case during flight, so that it sometimes failed to get its head into the pouch, and let a mealworm drop. When this was the case it never made any attempt to seize its prey again, and the mealworm would escape by crawling out from beneath its wings or tail. When the Bat was suspended, however, the bag was wide open, and the insect never escaped. Experience seemed to teach it that the mealworms were incapable of escape by flight, and latterly it did not always thrust its head into the interfemoral pouch after seizing one, but devoured it without this preliminary. In a free state, Bats capturing the greater part, if not all, of their food on the wing, must often fail to grip large insects securely at the first bite, and it would be a manifest advantage to have some means of adjusting their hold without alighting. An insect accidentally dropped during flight could hardly be recovered, and would probably be abandoned without further thought, as was the

[1] *Midland Naturalist*, 1883, 151.

[2] *Zoologist*, 1899, 51-53. Norton (*loc. cit.*, 152) had previously noticed that it could be caught by the wing with a rod and line baited with a fly or moth, the wing, as he thought, being used for striking at the bait.

case when my Whiskered Bat dropped a mealworm. A Long-eared Bat which I kept for a few days invariably thrust its head into the interfemoral pouch on seizing a moth. Both Long-eared and Whiskered Bats have the tail curved beneath them during flight, although they are usually figured with it held straight behind them ; and I have little doubt that when on the wing they actually use the method I have described for securing their prey. Further observation will probably show that this curious habit is common to all our British species, with the possible exception of the Horseshoe Bats, in which the interfemoral membrane is comparatively small, and the tail, during repose at any rate, is carried in a very different way.

"Having firmly secured its prey, whether moth or mealworm, by the head or tail, my Whiskered Bat used to swallow it lengthwise, crunching it thoroughly by rapid movements of the jaws as it slowly disappeared. Neither foot nor carpus was ever used in any way to assist it in capturing or holding an insect. The use of either would, of course, be quite impossible during flight. Moths and spiders moving near it were pounced upon and captured, but mealworms disassociated from my fingers seemed to puzzle it, and only once did I see it capture one itself, although the creatures frequently crawled just before its eyes and over its wings and feet. The wings and legs of moths were always dropped, but once or twice a wing accidentally encountered in the Bat's ramble about the table was picked up and eaten. The mealworms were, as a rule, entirely consumed, but sometimes the horny heads were left."

BECHSTEIN'S BAT.

MYOTIS BECHSTEINI (Kuhl).

1818. VESPERTILIO BECHSTEINII, Heinrich Kuhl, *Neue Ann. der Wetterauischen Gesellschaft für die gesammte Naturkunde*, I., i., 30, pl. 22 ; described from Hanau, Germany, from Leisler's MSS. ; Jenyns ; Bell (ed. 1) ; MacGillivray ; Blasius ; Clermont ; Fatio ; Bell (ed. 2) ; Dobson ; Flower and Lydekker ; Lydekker ; E. T. Newton, *Quart. Journ. Geol. Soc.* (London), August 1899, 420 ; Winge.

1829. NYSTACTES BECHSTEINII, Jakob Kaup, *System der Europäischen Thierwelt*, i., 106, 108-9.

1842. MYOTIS BECHSTEINII, J. E. Gray, *Ann. and Mag. Nat. Hist.*, Dec., 258 ; Fitzinger ; Thomas, *Zoologist*, 1898, 100 ; Méhely ; Johnston ; Millais.

1856. MYOTUS BECHSTEINII, F. A. Kolenati, *Algemeine deutsche Naturhist. Zeitung* (Dresden), Neue Folge, ii., 131 and 179.



1



2



3

WINGS ($\frac{1}{2}$ natural size and diagrammatic) OF

1. *Myotis mystacinus.* 2. *M. bechsteini.* 3. *M. nattereri.*

1902. VESPERTILIO BECHSTEINII GHIDINII, Victor Fatio, *Rev. Suisse de Zool.*, 10, 400; see Mottaz, *Bull. Soc. Zool.* (Geneva), Nov. 15, 1908, 160; described from Gerso, near Lugano, Tessin, Switzerland.

1906. MYOTIS BECHSTEINI FAVONICUS, Oldfield Thomas, *Ann. and Mag. Nat. Hist.*, Sept., 220; described from La Granja, Sierra de Guadarrama, Central Spain.

1910. MYOTIS (MYOTIS) BECHSTEINI, E.-L. Trouessart, *Faune des Mammifères d'Europe*, 30.

Distribution:—The exact range of Bechstein's Bat is little known, but it certainly occurs from Sweden to central Spain and from England to Hungary. In Britain it is only known from **England**, its occurrences wherein are detailed below.

Distribution in time:—Remains of bats from the Pleistocene deposits of Ightham Fissure, Kent, were assigned by E. T. Newton to this species, or, possibly, to *M. murinus* = *myosotis* (*Quart. Journ. Geol. Soc.*, August 1899, 420).

The **period of gestation** is unknown; **the number of young** is probably one only, born in midsummer (Blasius; C. L. Brehm).

Description:—Bechstein's is the largest British member of its genus.

The **ear** is long and unnotched (Fig. 2, No. 7, p. 7). When laid forward, it stretches beyond the tip of the nose by about half its length; the outer margin is very slightly flattened beneath the tip, then convex to a point very nearly opposite the base of the tragus, then slightly emarginate and terminating in a small convex lobe; the inner margin is convex for the lower two-thirds of its length, and then straight or slightly concave to a rounded point: there are nine or ten cross-folds.

The tragus (Fig. 2, No. 7, p. 7) attains its greatest breadth at a point close to its base; it is curved outwards above, and tapers to an acute point at about opposite to the middle part of the ear; the inner margin is straight below, slightly convex above; the outer margin is quite distinctly concave above, markedly convex below, terminating after an emargination in a small triangular basal lobe.

The **wing** (Plate XIII., Fig. 2) arises from the base of the toes. In the two New Forest specimens the third and fifth metacarpals are about of equal length, but in those from the Isle of Wight the third is slightly the longer of the two. The thumb is long; the area of wing between digits two and three is large; the tail-tip is free of the interfemoral membrane. The most conspicuous features are the exceptionally long lower leg, but comparatively short longest digit. With a forearm about equal in length to that of *Nyctalus leisleri*, the lower leg is but little shorter than that of *Vespertilio serotinus*, but the longest digit and expanse are far short of those of either, while the third and fifth metacarpals are about equal to those of *B. barbastellus*.

As compared with the forearm, the lower leg is only equalled or exceeded in *Plecotus* or *Barbastella*. The third metacarpal and longest digit are the shortest amongst British vespertilionid bats.

The wing is therefore of expanse under the average, broad at its base, with an ample interfemoral membrane. It is poorly developed at the extremity. The thumb is long.

The **fur** is soft and woolly. The face (Plate XIV., Fig. 1) is thinly haired except on the forehead, and there are a few moustache-like hairs on the muzzle. The wing is comparatively free of hairs, the hair of the body not extending farther than about to a line joining the middle points of humerus and femur, and very slightly to the interfemoral membrane. The ear is free of hair except externally at the base and a fringe on the lower third of the outer margin.

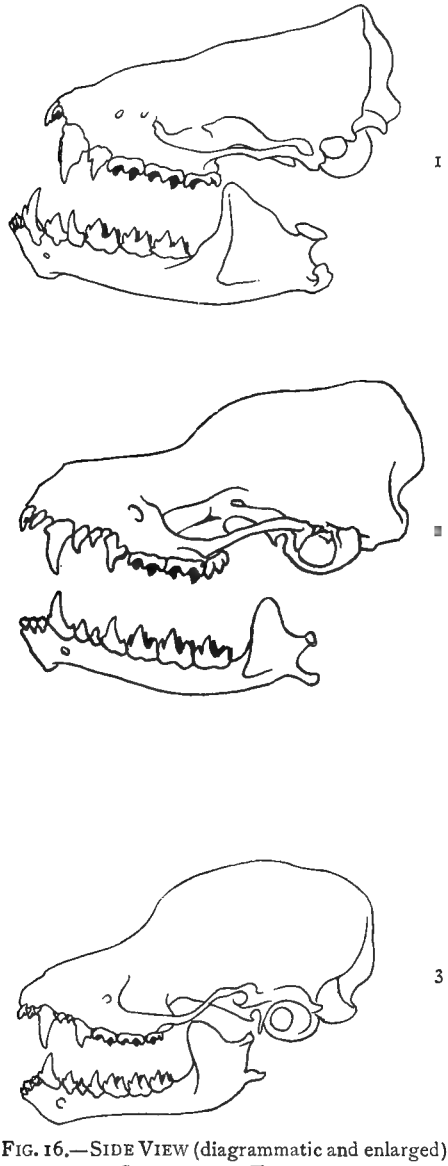


FIG. 16.—SIDE VIEW (diagrammatic and enlarged) OF SKULLS AND TEETH OF
1. *Nyctalus leisleri.* 2. *Myotis bechsteini.* 3. *M. nattereri.*



FIG. 17.—FRONT VIEW OF INCISORS AND CANINES OF *Myotis bechsteini* (enlarged and diagrammatic).

The **colour** is very similar to that of *M. nattereri*, the bases of the hairs being everywhere dusky, with the tips some shade of wood-brown

above, whitish beneath. The moderately distinct line of demarcation passes along the line of junction between wing and body and thence to the base of the ear.

The **skull**, as compared with that of *M. nattereri*, is larger, but narrower; it carries more prominently developed cranial ridges and much bigger bullæ (Fig. 16, No. 2, p. 174).

The **teeth** are similar to those of *M. mystacinus*, but the tip of the middle upper premolar reaches far beyond the cingula of the neighbouring teeth (Figs. 16, No. 2, and 17, p. 174).

The **geographical variation** of this rare bat is almost an unknown quantity, but Thomas has rightly separated central Spanish examples from Hungarian as the sub-species *favonicus* on the ground of their markedly smaller ears and bullæ. I cannot distinguish the few British specimens available from the type of *favonicus*, but await further material before identifying the British Bechstein's Bat with that form. Both are distinctly smaller than the Hungarian.

DIMENSIONS IN MILLIMETRES:—

	Head and body.	Ear, greatest length.	Tragus, greatest length.	Tail.	Lower leg.	Hind foot, without claws.	Forearm.	Thumb, without claw.	Longest digit.	Metacarpal II.	Metacarpal V.	Greatest expanse of wings.
Two, New Forest, July 1886 (E. W. H. Blagg), from old skins	..	19 18·5	10 9	35 35	20 19	10·75 10	43 42	7 7	64 64	35 33	34·5 33	248 252
Male, Henley-on-Thames, 10th March 1901 (J. G. Millais, British Museum), from dried skin	..	18	..	..	19	10	39	7	59	30·5	31	..
Male, Isle of Wight, 14th Aug. 1909 (P. Wadham)	[52]	19	8	..	20	..	42	7+	67	35	34+	..
Female, do. 31st July 1909	[52]	19	8	34	20	8·5	39	7+	65	35	34	..
Average	..	18·7	8·7	35	19·5	?	41	7	64	33·5	33	[250]

Proportionate lengths:—Foot, without claws, about ·53 of lower leg; fifth metacarpal about equal to third; lower leg about ·46 of forearm.

Skull:—Greatest length, 17; basal length in middle line, 12·25; palatal length in middle line, 7·5; from posterior border of m^3 to anterior border of canine, 6·5; same in lower jaw, 7·25; greatest breadth at zygoma, 9; posterior breadth, 8; breadth between orbits, 7; breadth at constriction, 4·5.

Distinguishing characters:—The large ear of Bechstein's Bat marks it off very distinctly from every other British species except the Long-eared, in which the ears meet at their anterior margins. In other

respects it approaches nearer to Natterer's, but the ciliated posterior margin of the interfemoral membrane and the relatively longer tragus of the latter are diagnostic. Its closest ally is, perhaps, *M. myosotis* of continental Europe, a much larger bat, with relatively shorter ear, cigar- not sickle-shaped tragus, and wing arising slightly above the base of the toes.

This handsome and striking species is probably the rarest of undoubtedly British bats, and was for long known in this country solely from a specimen now in the British Museum, taken in the New Forest before 1837 by Millard. Its occurrence in this locality was verified by Mr E. W. H. Blagg, who in a somewhat laconic note,[1] written two years after the event, described his good fortune in having in July 1886 discovered a colony of about a dozen in a hole made by a woodpecker. Of these he secured two, and has since presented them to the British Museum. Another, an old male, was shot by Mr W. C. Ruskin Butterfield near Normanhurst, Battle, Sussex, on 28th July 1896.[2] This bat was examined by the late Sir William Flower, and was lent to the Corporation Museum at Hastings in 1898. Unfortunately it has been mislaid, and is not at the present time forthcoming; Mr Butterfield writes me that he fears that it has been accidentally destroyed. Then, in March 1901, Mr J. G. Millais found an adult male in Mr Heatley Noble's chalk cavern near Henley-on-Thames.[3] Lastly, on 31st July 1909, Mr Percy Wadham captured an adult male near Newport, in the Isle of Wight.[4] It was sent to Mr H. G. Jeffery for preservation, and was identified by that gentleman and by him sent to the British Museum for verification, with a female taken by Mr Wadham at the same place on 14th August. I am indebted to the owner and to Mr Jeffery for the opportunity of examining these two bats, which have been set up by Mr Jeffery for Mr Wadham's collection. Other British records have proved to be erroneous, viz., that of two examples taken at Preston, near Brighton, and identified with this species by Frederick

[1] *Zoologist*, 1888, 260. [2] *Sussex*, i., 301.

[3] In Berkshire, not Oxfordshire (see A. H. Cocks, *Zoologist*, 1910, 74).

[4] Recorded by J. E. Harting, *Field*, 20th Nov. 1909, 889; and by J. E. Kelsall, *Zoologist*, 1910, 30.

Bond, but later assigned by Messrs Millais and J. E. Harting to Natterer's Bat;[1] and that of a specimen in the Oxford Museum, taken at Godstow, in Berkshire, by Frank Norton, which was mentioned by H. A. Macpherson as Bechstein's,[2] but referred by the Rev. J. E. Kelsall[3] to Natterer's Bat.

The habits of Bechstein's Bat have never been studied in detail. Blasius writes that in Germany its haunts are woods or large orchards and the neighbourhood of buildings, where it lives in small, dry holes in trees. It commences its flight late in the evening, flying slowly and at a low elevation over lanes and forest roadways, and may be recognised while on the wing by its long ears. It is said not to appear until late in the spring, to fly only in fine, calm weather, and not to venture abroad in winter. In Germany, Blasius on two occasions found one young one with its mother, and, about eighty years ago, on 9th June, C. L. Brehm[4] took a party of twenty-two females, of which seventeen proved to be pregnant with young almost ready for birth. Kuhl also found as many as thirteen females together. The occurrence of so many examples of one sex together in the breeding season suggests that in this respect the habits of this bat may resemble those of the Noctule. Mr Millais' example was lying in a crevice close to a couple of Natterer's Bats. It was wide awake, and when handled remonstrated by biting and uttering a series of querulous screeches, not unlike the cries of a very young child. Mr Wadham's bats were taken at dusk near a withy bed and small group of trees, from which the Lukely runs for about a hundred yards by open meadows to a large mill pond and reed bed.

The long unnotched ears of this bat differentiate it absolutely from all the other British members of its genus. Natterer's Bat approaches it most nearly, but the relatively longer tragus, slightly notched ears, and ciliated posterior margin of the interfemoral membrane in that species are quite distinctive.

[1] Harting, *Zoologist*, 1887, 162; Millais, *British Mammals*, i., 98.
[2] *Midland Naturalist*, 1883, 153.
[3] *Zoologist*, 1884, 483; 1885, 146.
[4] *Ornis* (Jena), 1827, iii., No. 3, 20.

NATTERER'S BAT.

MYOTIS NATTERERI (Kuhl).

1818. VESPERTILIO NATTERERI, Heinrich Kuhl, *Neue Ann. der Wetterauischen Gesellschaft für die gesammte Naturkunde*, i., 1, 33, pl. xxiii.; described from Hanau, Germany; Jenyns; Bell (ed. 1); MacGillivray; Blasius; Clermont; Fatio; Bell (ed. 2); Flower and Lydekker; E. T. Newton, *Quart. Journ. Geol. Soc.* (London), May 1894, 192; Lydekker; Winge.

1842. MYOTIS NATTERERI, J. E. Gray, *Ann. and Mag., Nat. Hist.*, Dec., 258; Fitzinger; Thomas, *Zoologist*, 1898, 100; Johnston; Méhely; Millais.

1856. ISOTUS NATTERERII, F. A. Kolenati, *Algemeine deutsche, Naturhist. Zeitung* (Dresden), Neue Folge, ii., 131 and 177.

1862-63. ISOTUS NATTERERI, var. TYPUS, and var. SPELAEUS, Carl Koch, *Jahrbücher des Vereins für Naturkunde im Herzogthum* (Nassau), xviii., 426 and 430; described from Nassau, Germany.

1910. MYOTIS (MYOTIS) NATTERERI, E.-L. Trouessart, *Faune des Mammifères d'Europe*, 29.

Reddish-grey Bat of Bell and others, but there are no **local names.**

Distribution:—Natterer's Bat ranges through boreal and temperate Europe and Asia from southern Sweden to Seville, Spain, and Arezzo, Tuscany (specimens in British Museum), and from Ireland to Kiushiu, Japan, where the representative sub-species is *M. n. bombinus* of Thomas (*Proc. Zool. Soc.* (London), 28th Nov., 1905, 337). It ascends to 2300 feet in the Caucasus (Satunin).

M. thysanodes of Miller (*North American Fauna*, 13, 1897, 80-85), of the lower Sonoran zone from near the southern border of the western United States to San Luis, Potosi and Michoacan, is probably the representative in America.

Thanks to Harting (*Zoologist*, 1889, 245-47), the distribution of *M. nattereri* in the **British Isles** is now fairly well known. In **England** it is found from Cornwall and the Isle of Wight to Durham in the north and to Norfolk in the east. When Harting wrote there were fourteen counties within the above area in which it had not been found. Five only of these now remain, absolutely without records, viz., Wiltshire, Hereford, Buckingham, Hertford, and Rutland. It has twice been taken close to the Buckingham border (see Cocks; also Steele Elliott, *Zoologist*, 1903, 349), and our ignorance of it in this as in the other counties is due almost certainly to want of observation.

In **Wales** it probably occurs in every county, having been recorded by William Thompson (*Proc. Zool. Soc.* (London), 13th June 1837, 52), from Harlech Castle, Merioneth, in the extreme west, a locality in which J. Backhouse, jun., still finds it (Forrest, MSS., and *Zoologist*, 1898, 493, and specimen in British Museum); and in 1903 from St David's, Pembroke (Forrest). In 1905 Coward and Oldham identified one while flying in broad daylight near the Cefn cave, St Asaph, Denbigh; in the

same year Mills examined one shot in Pembroke, while in 1907 Oldham saw in the possession of Owen two live ones taken in Cardigan (all in lit.).

Within these limits it is probably numerous, although no doubt overlooked, in most, if not all of the wooded localities, being reported, for instance, as plentiful at Stainborough, Yorkshire (Armitage, *Naturalist*, 1905, 37), and as one of the commonest species at Colchester (Laver). It has even been taken in Thayer Street, Manchester Square, London (Harting, *Zoologist*, 1888, 25).

In the extreme north of England it has never been reported from Westmorland or Northumberland, but the occurrence of a numerous colony at Castletown, near Carlisle, Cumberland, probably indicates its abundance right up to the Scottish border (Macpherson).

From **Scotland** two specimens only are recorded, neither of which, unfortunately, is regarded by Scottish naturalists as absolutely satisfactory. The first of these, an immature male in the British Museum (*not* an adult female as in Dobson's *Catalogue of Chiroptera*, 308), is registered as from Inveraray, Argyll, August 1858; it had escaped the recollection of the (supposed) donor, the late Duke of Argyll, but there seems to be no valid reason for doubting its authenticity.[1] The second, a roughly preserved skin, unfortunately without a label, from the collection of the late Robert Gray, is now in the possession of W. Evans: it may with much probability be connected with Gray's statement to Harvie-Brown that he had found this bat "in some plenty" near Dalkeith, Midlothian, "in dozens in the hole of a tree," this was in 1880 (W. Evans, *Proc. Roy. Phys. Soc.*, Edinburgh, xvi., No. 8, 388, 27th November 1905). The whole matter has been fully discussed by W. Evans (*Mammalian Fauna of Edinburgh*, 22-23, and *Ann. Scott. Nat. Hist.*, 1901, 129-131), and at any rate there would seem to be no inherent improbability in the occurrence of this species in Scotland. Coward, it may be mentioned, has a specimen in alcohol, which he believes he received alive from Montrose in 1895; but an undoubted error on the label of the bottle prevents him from making a definite statement.

In **Ireland** the species was first made known from an example procured by Mangan at the Scalp, Enniskerry, almost on the Dublin border of County Wicklow, in 1845, and presented through M'Coy to the Dublin Natural History Society (*Proc.*, 12th February 1845; J. R. Kinahan, *Proc.*, 9th December 1853, published in Dublin *Nat. Hist. Review*, i., 23, 1854; see also ii., 8, 1855, also vi., 383, 1859; M'Coy, *Ann. Mag. Nat. Hist.*, April 1845, 270). Dobson had a specimen, still in the British Museum, and dated 1876, from Co. Longford, and the bat has since been detected in Donegal, Fermanagh,

[1] I have searched in the Duke's correspondence at the Museum, but can find no reference to this specimen; the entry in the register is, however, quite clear.

Louth, Longford (Jameson, *Irish Naturalist*, 1897, 39), Cork (Folliott Darling, *Zoologist*, 1883, 294), Galway (Kane, *Irish Naturalist*, 1894, 116, and 1897, 88; also a specimen from Woodpark, in the British Museum), Antrim (Patterson, *Journ. cit.*, 1900, 274), Carlow (Pack-Beresford, *Journ. cit.*, 1905, 228), a combination of counties indicating a wide distribution throughout the island. (Jameson suggests that Kinahan's error in identifying the Tankardstown Bridge, Co. Kildare, colony of *M. daubentoni* with this species may have been founded upon an actual mixture of the two—see *Journ. cit.*, 1897, 40.)

Distribution in time:—Of very numerous remains of bats found by Lewis Abbott in the Pleistocene deposits of Ightham Fissure, Kent, the greater number are referred to this species by E. T. Newton, who states that they are sufficiently perfect as to leave little doubt as to the correctness of the determination (*Quart. Journ. Geol. Soc.*, May 1894, 192).

The **period of gestation** is unknown. The **number of young** at a birth does not appear to exceed one (Blasius), born probably in the latter half of June (Proger): they have been found not long after birth on 25th July (J. Backhouse, jun.).

Description:—Natterer's Bat resembles Bechstein's, but is smaller and with quite distinct ear and wing.

The **head** (Plate XI., Fig. 3) is proportionately small, the upper jaw overhanging and naked at its extremity, the face is hairy and moustached, and there are two prominent glands, one on each side above the lips.

The **ear** (Fig. 2, No. 8, p. 7) is large, and when laid forward reaches slightly beyond the tip of the nose. It is nearly oval in shape, with convex inner margin, and the outer also as a whole convex, but its regularity interrupted by a notch at about one-third of the distance from the tip and ending in a distinct basal lobe. There are only five cross-folds. The tragus is long, narrow, and pointed, and attains its greatest breadth near its base, where it is deeply emarginate and conspicuously lobed; its tip lies about opposite to the upper cross-fold at about two-thirds the height of the ear. The inner margin is nearly straight, or slightly convex, the outer slightly serrated and concave above.

The **wing** (Plate XIII., Fig. 3) is the longest found amongst British bats of this genus, both forearm and longest digit being of exceptional length. It is also broad, since the third and fifth metacarpals are about of equal length. On the other hand, both foot and lower leg are small, relatively and actually, and the interfemoral membrane is narrow and inconspicuous. Its posterior margin is crenated and furnished with a fringe of stiff short hairs, most conspicuous between the tail and the calcar, which is almost as long as in *M. daubentoni*. The thumb is weak.

The **fur** is long, thick, and soft, and extends to the face so as to



1



2



3



4

HEADS (natural size) OF

1. *Myotis bechsteini.*

2 and 3. *Barbastella barbastellus* (front and side views).

4. *Plecotus auritus.*

conceal the small eyes. On the wing it extends above and below about to a line joining the central points of humerus and femur, and is not conspicuous on the interfemoral membrane. The foot is ciliated with dusky hairs.

In **colour** this bat is very distinctly bicolored, being greyish brown—between "wood brown" or "isabella" colour, and "drab"—above and whitish below, the bases of the hairs always dusky or dark brown, and the tips grizzled and shining above. The line of demarcation is distinct, and passes approximately from the angle of the mouth to the junction of the wing and body. The membranous parts are dusky.

In the young the grizzled hair-tips are wanting, and the colour contrast is greater, the upper surface being darker—"mummy brown" almost to "seal brown"—and the lower surface a clearer white. The skin of the foetus is dusky (Proger).

In the **skull** (Fig. 16, No. 3, p. 174) the profile resembles that of *M. mystacinus*, but the brain-case is far more prominently raised above the face-line and more rounded.

In the **teeth** (Fig. 16, No. 3, p. 174, and Fig. 18) the middle upper premolar (there is some variation) is usually about half the size of the anterior, but sometimes almost equals it in diameter and length.

Geographical variation has not been studied, except in the sub-species *M. n. bombinus* of Japan, which is stated to be characterised by more abrupt and considerable inflation of the frontal region of the skull and by darker colour.

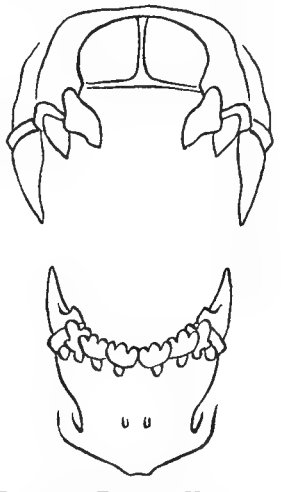


FIG. 18.—FRONT VIEW OF INCISORS AND CANINES OF *Myotis nattereri* (enlarged and diagrammatic).

Dimensions in millimetres (see following page).

Proportionate lengths:—Foot, without claws, about ·48 of lower leg; third metacarpal, about ·99 of fifth; lower leg, about ·41 of forearm, and about ·36 of head and body.

Skull:—Greatest length, 15·5; basal length in middle line, 11·25; palatal length in middle line, 7; from posterior border of m^3 to anterior border of canine, 6; ditto in lower jaw, 6; greatest breadth at zygoma, 9·5; posterior breadth, 7·5; breadth between orbits, 7; breadth at constriction, 4.

Distinguishing characteristics:—The light colour, large notched ear, elongated tragus, and particularly the ciliated interfemoral membrane, distinguish this bat absolutely from any other British species.

DIMENSIONS IN MILLIMETRES:—

	Head and body.	Ear, greatest length.	Tragus, greatest length.	Tail.	Lower leg.	Hind foot, without claws.	Forearm.	Thumb, without claw.	Longest digit.	Metacarpal III.	Metacarpal V.	Greatest expanse of wings.
Males.												
Male (British Museum) .	42	16·5	10	38	17	8	40	6	66·5	33	32·5	..
Male, Bedfordshire (measured from dried skin) .	42	15		41	..	8	.	..	..	..	..	..
Male, Galway (Dublin Museum)	..		..	..	17	8	39	6	68·25	34	33	..
Females.												
Female, received from A. Whitaker, Yorkshire, 10th October 1906 (measured in the flesh) . . .	43	..	..	32	..	..	..	..	..	..		..
Female in alcohol (Tomes' collection, in British Museum)	..	14	10		16·5	8·25	40	5	64	33	32	..
Female (do.)	..	14	9	.	16	8	40	6	65	33	32	..
Female (do.)	..	14·5	9·5	..	16	8	39	6	66·5	34·5	34	..
Female (do.)	..	14	8	..	16	8	40	4·75	69	35·5	33	
Female (do.)	..	14	9·75	..	16·5	8·5	38	6·5	63·75	33	32	.
Female (do.)	..	17·5	9	..	16·5	8	39	6·75	65·5	33	32	..
Female (do.)	..	14	8	..	17	7·5	39	6	65·5	34·5	33	..
Female, Northants .	46	14	9	36	17	7·5	39	6·5	65	35	33	
Female, do. . . .	47	14	9	33	16	8	39	6	65	34	33·5	.
Female, England (Bartlett: British Museum) . .	42	15	9·5	..	16·75	8	39	5	65·75	34·5	34	..
Female, Berks, measured from dried skin . .	49	16·5	9	40	..	..	..	..	..	..	..	267
Female, Ilminster . .	46	17	..	43	..	..	42·5	..	..	..	..	285
Female, N. Wales (the last three in British Museum)	43	16	8	42	..	..	..	..	..	..	..	272
Female, Co. Fermanagh (Dublin Museum) . .	..	..	..	..	17·25	9	39	6·0	67·5	35	34·75	..
Average of females (approximate) .	45·1	14·9	9	37·6	16·5	8	39·4	5·8	65·6	33·1	33	[274]

Note:—The above measurements, except where otherwise stated, were taken from specimens in alcohol.

This species, to which the inappropriate name of Reddish-grey was applied, it is believed, in the first instance by Bell, was described by Kuhl in 1818, and by him named after the Austrian naturalist, Natterer. In Britain it was recognised by Jenyns (who gave it a place in his *Manual*), by Yarrell,[1] William Thompson of Belfast, and Bell, but it for long retained the reputation of being, if not of unfrequent, at least of purely local occurrence. It is now known to be widely distributed in some numbers throughout the greater part of England, having been found in almost every district where bats have been the subject of expert study.

[1] In Jenyns.

Natterer's Bat is as sociable and gregarious as the Whiskered Bat was formerly reputed solitary. It is often abundant in wooded localities, where it haunts, usually with slow and steady flight at no great altitude, the open spaces amongst the trees or the neighbourhood of old gardens. By day it retreats to holes in walls[1] or trees,[2] or to caverns, and in the latter is often found in company with other species, such as the Whiskered and Long-eared Bats, with which it will even share the same crevice.[3] The recesses of caves are, however, more favoured for purposes of winter hibernation than for the briefer retirements of summer. Occasionally it breaks its rule by hanging alone in hibernation.

A favourite winter resort is Mr Heatley Noble's cavern near Henley-on-Thames. Here it was found numerously in company with other bats on 14th February 1906. By the 15th of the following month, however, all except four, and they, strange to say, numbering as many species as individuals, had departed, and by the 25th of the same month, only one, a Daubenton's, remained.[4] Hibernation is, therefore, not more profound than in other species, and in South Wales, Mr T. W. Proger has known this bat to fly abroad for its food in February.

The late R. F. Tomes graphically described for Bell's work a colony of these bats which he discovered in 1848 in the church of the village of Arrow, near Alcester. "Between the ceiling of the church and the tiled roof was a dark retreat, accessible by a low arch from a floor in the tower. Here the Bats were seen adhering, by all their extremities, to the under surface of the row of tiles which forms the crest or ridge of the roof (partly supported, however, by the upper tier of roof-tiles on which the ridge-tiles rested), and others clinging to them, until a mass was made up three or four inches thick, six or seven wide, and about four feet in length. It would be wrong to call this their place of repose, as they presented a most singular scene of activity, the constant endeavour of those

[1] Alfred Newton, *Zoologist*, 1853, 3804; J. Backhouse, *ibid.*, 1898, 493.
[2] William Borrer, *ibid.*, 1874, 4127.
[3] Joseph Armitage, *Naturalist*, 1900, 114, and other references.
[4] A. H. Cocks, *Zoologist*, 1906, 186-187.

outside being to penetrate the mass, probably for warmth, and to do this they were continually poking their noses between those nearest to them, and then forcing in their bodies, to be in their turn again pushed to the outside. In this manner a regular bickering was kept up in the whole mass. However, they seemed to be very gentle, and to have no idea of biting or otherwise annoying each other.

"On the boarded floor in the tower adjoining this retreat many dead ones were lying about, in a dried condition, all of them very small and hairless. These probably had fallen from their mothers when on the wing, as they were themselves too young to have flown there, and the parents could not have rested in this chamber, and at that time let fall their young.

"After watching this remarkable assemblage for some time, about sixty were secured in a bag (only a very small proportion of the number there), and the bag was opened in a lighted room in the evening. They were soon flying about in all directions. On the window being thrown open, those nearest to it at once flew out; but so completely gregarious are these Bats, that after taking a turn or two outside they re-entered the room, and being joined by others, again went forth, and again returned, until all had become aware of the means of escape, when the whole company left the room in a cloud. We may add, as further showing the gregarious nature of the species, that a few which were retained, exhibited great uneasiness when separated from each other, which disappeared when permitted to be together."

The gentle nature of this bat was also remarked upon by Bell, who kept three in captivity for some little time, and found that they readily took food from his hand, yet their apparently friendly disposition, both to himself and to their companions, did not prevent two of them from devouring one night the body of the third. They were active in their habits, "running about the cage and climbing with great agility."

Mr J. E. Harting,[1] who has seen a good deal of this bat in west Sussex, finds it in the habit of flying about the oak trees on the outskirts of the woods, appearing earlier in the day—even before sunset—than the other local species, and

[1] *Zoologist*, 1889, 241-248.

allowing so near an approach as to be identified while on the wing. Its flight when feeding was by no means rapid, but on leaving one tree for another at a little distance it flew much faster, yet never so rapidly as the Pipistrelle or high-flying Noctule. So far as could be ascertained without actual examination of the prey captured, its food appeared to consist principally of small flies and moths, which it captured not only on the wing, but snatched off the leaves on the outside branches of the trees with great dexterity. Just as a dog will "bolt" a rabbit and catch it before it has gone many yards, so one would disturb a small moth and seize it within a few inches of the leaf or twig on which it had been resting. Apparently the bat is noisy while on the wing, since its voice recalled to Mr Harting the well-known lines in Collins's "Ode to Evening":—

> "Now air is hushed, save where the weak-eyed Bat
> With short shrill shriek flits by on leathern wing."

At Colchester the peculiar squeak is heard more frequently by Dr Henry Laver than the voice of any other species.

Mr Harting has noticed Natterer's Bat on more than one occasion feeding in bright sunshine, as early as 3 P.M. in August. His observations are confirmed by Mr J. Ffolliott Darling,[1] who once caught one in April in County Cork flying about a wood in bright sunlight at about the same hour, and by Messrs T. A. Coward and Charles Oldham, who obtained a good view of one outside the Cefn Caves, near St Asaph, Wales, again at 3 P.M. on 2nd December 1905. The last, however, had possibly been disturbed from the caves.

The young, the number of which, according to Blasius, does not exceed one each year, are found in summer in the mixed colonies of their elders. Mr J. Backhouse, jun.,[2] received several already well-grown from the ruins of Harlech Castle, north Wales, in July (Mr Oxley Grabham writes me that the exact date was the 25th), and this agrees with Mr Proger's statement that in south Wales they are usually born towards the end of June, on the 22nd of which month he once caught a female bearing her young on the wing.[3]

[1] *Zoologist*, 1883, 294. [2] *Ibid.*, 1898, 493.

[3] Paper read before the Biological and Geological Section of the Cardiff Naturalists' Society, March 1905, 5; also in MSS.

The best account of this bat while in captivity is that of Mr Coward,[1] based upon an example which he had in his possession for some little time. He corroborates previous writers in regard to the docility and gentleness of the species, which readily acquired the habit of eating mealworms after two had been placed in its mouth. Mr O. V. Aplin[2] alone accuses it of fierceness: "having bitten, it retains its grip with the tenacity of a bulldog."

According to Mr Coward, the two most remarkable features were the method of carrying the tail in flight and the manner of alighting. Unlike many other species, such as its congener the Whiskered Bat, it carried its tail in an extended position behind it, not half-bent beneath the body. In spite of this, the tail resumed the curve usual in bats when the animal rested on a flat surface, and troublesome insects were pouched in the orthodox manner if it was fed when hanging or resting in a horizontal position.

This bat devoured—besides mealworms—flies, bluebottles, crane-flies, spiders, wood-lice, beetles and moths, in the latter case rejecting the head and wings. Though usually attempting to eat anything that was offered to it, it was more particular about its food than some other species, and it invariably dropped cooked or uncooked meat or shreds of fish. "Most spiders," Mr Coward writes, "were eaten rapidly, but one or two with conspicuous markings were snatched and then rejected; a carnivorous beetle[3] was not only treated in the same way, but the Bat, by spitting and shaking its head, showed evident signs of disgust."

"At times it used the carpus to hold a struggling mealworm, and would stand, when engaged in eating, with one wing slightly raised, as if ready to hold its prey if it proved too powerful; it never used the thumb in any way to tear its prey. In its normal position when feeding, its head was held rather low and its shoulders were somewhat hunched up. When searching for food or flying round, it either held its mouth open or chattered, opening and shutting its mouth with great rapidity." Its sight appeared to be bad and it made many wild snatches at nothing when an insect was moving in its cage, yet

[1] *Zoologist*, 1905, 51-56. [2] *Ibid.*, 1889, 382. [3] *Carabus*.

it generally managed to clear its cage of living insects during the night.

When sleeping this bat did not always hang by its feet, but often lay prone on the floor of the cage. It did not as a rule remain on the wing for more than ten or twenty minutes at a time, after which period it would alight for rest. In doing so "it frequently seized hold first with its thumbs, and then did not shuffle round so rapidly as those Bats do which invariably settle in this manner; a Noctule, Long-eared or Whiskered Bat clutches the object to which it intends to hang with its thumbs, and with great rapidity twists itself round so as to gain the usual reversed position. The Lesser Horseshoe performs a more remarkable feat: it flies to within an inch or so of the object, and then reverses itself in the air, catching first with its feet; in this way it is ready at once to drop from its hold and fly. When my Natterer's Bat wished to settle on certain objects—especially on the tip of one of a pair of Fallow-deer antlers over the door—it sometimes turned in the air after the manner of a Horseshoe. This action was not so clean or certain as in the case of a Horseshoe, and occasionally the Bat missed its hold and fell, generally recovering itself before it had fallen many inches. It was somewhat remarkable that it shared the habits of both the *Vespertilionidæ* and the *Rhinolophidæ* (for the Greater Horseshoe reverses in the air) in this respect, but did not perform either action with the same celerity or ease."

Its voice is described as consisting of two notes, of which "one—pitched much lower than the other—was a low chatter rather than the usual high-pitched cry of a Bat."

Mr Coward suggests that "if some of the habits of this example were typical of the species, we may see in Natterer's Bat the first traces of habits which have become constant in the specialised *Rhinolophidæ*. In the Horseshoes the short tail is carried recurved over the back; in *Pterygistes*,[1] *Pipistrellus*, *Plecotus*, and some species of *Myotis*, it is usually carried curved beneath the body; in *M. nattereri* we find the tail, although used as a pouch, is carried extended behind the body. Again, the habit of turning in the air before alighting appears

[1] I.e., *Nyctalus*.

to be constant in the *Rhinolophidæ*, and seldom noticeable in the *Vespertilionidæ*, except in this species, where we find the Bat sometimes alights in one way and sometimes in the other." Thus, in habits, Natterer's Bat shares some of the characteristics of each family, and it is noticeable that the small interfemoral membrane and weak thumbs recall those of the Horseshoes, so that structure and habits go together. In other respects, such as the position of the wings when sleeping, Natterer's Bat is not known to differ from its near relations.

Mr Arthur Whitaker[1] has described an interesting experiment, which, without resorting to the cruel artifices of Spallanzani and other continental naturalists, enabled him to demonstrate that the flight of a bat of this species was in no way dependent upon the uninterrupted use of its eyes. The animal having been rendered temporarily stone-blind by means of wax, was released in a room in which it had never been before and with which it was consequently quite unfamiliar. Usually when captive bats are allowed to exercise themselves in this room they fly in circles close to the ceiling, but the behaviour of this blinded bat was somewhat different. "When released," writes Mr Whitaker, "it commenced to fly in a rather slow and hesitating manner, but with rapidly-growing confidence. It went first straight for the closed door, and, I thought, was about to fly right against it, but it suddenly turned itself when but a few inches off, and hovered slowly once or twice along the top edge and down the side, still without touching, but following, I feel convinced, the slight draught of air admitted. Having apparently satisfied itself that there was no exit large enough for it there, it turned round, and flew the length of the room, straight for the fireplace, still, I believe, following the draught. When it got near the fire it turned, warned, no doubt, by the heat, and then commenced to fly slowly and cautiously about the room at a height of about six inches from the floor, and I noticed it repeatedly pause and hover in front of the wainscot at one point where it had sprung slightly from the wall and admitted a distinct current of air. Although it flew fairly quickly, and kept passing underneath the chairs, of which there were over a dozen in the room, it

[1] *Naturalist*, 1906, 148-149.

never once, so far as I could see by lying down to watch it, even touched anything with the tip of its wings. An attempt on my part to catch it caused it to fly up to the ceiling, and just below this it commenced circling round and round rapidly, repeatedly dipping to pass under a beam crossing the centre of the ceiling. I tried holding a walking-stick perfectly still in its path, but it would swerve suddenly when but a few inches from it. After flying for over twenty minutes it suddenly settled on a chain supporting one of the weights of the gas chandelier, and that it could settle in such a place is in itself a wonderful proof of the accuracy of this 'second sight.'

"I stood on a chair and approached my hand very slowly in order to catch it again, but when my hand was within about a foot of it, it commenced to turn its head nervously and jerkily from side to side (an action characteristic of a bat when disturbed), and flew again before I could get hold of it.

"Eventually I was obliged to get out my butterfly net to catch it, and even then had some little difficulty. . . .

"When I caught my bat again I found the wax still adhering properly and quite covering the eyes."

Natterer's Bat, should a tolerable view be obtained of it, is one of the easiest of all British species to identify while on the wing. The light colour of the under parts, the long ears—longer than those of any species except the rare Bechstein's and the Long-eared—and the general size, which is about a quarter as large again as the Pipistrelle, Daubenton's, or Whiskered Bat, form an unique combination amongst British species.

[THE NOTCH-EARED BAT.

MYOTIS EMARGINATUS (Geoffroy).

A few lines are necessary in regard to other reputedly British species of this genus.

Of these the present was described and figured by Isidore Geoffroy in 1806,[1] and redescribed in error by J. H. Blasius in 1853.[2] Geoffroy's types came from Abbeville, France, and the inclusion of the species in the British list is due to his

[1] *Ann. du Museum d'Hist. Nat.*, viii., 198.

[2] As *ciliatus*, Wiegmann's *Archiv für Naturgeschichte*, XIX., i., 288-293.

statement, which forms part of the original description, that he received from Alexander Brogniart a single specimen taken "*sur sa route*" near Dover. From this scanty information he concluded that the species must be "*assez commune en Angleterre.*"

Many naturalists have expressed conflicting opinions as to this bat, which is found so near Britain that its occurrence within our boundaries would not appear to be very unlikely. De Selys[1] appears to have been the first to accept it as a distinct species allied to *M. nattereri*, and R. F. Tomes,[2] although he believed that Geoffroy's type-specimen was a *M. mystacinus*, after examination of specimens in continental museums, pointed out that it was a form quite different from anything British.

This bat, which ranges at least as far east as Hungary, combines an ear even more fully notched than that of *M. mystacinus*, with a narrow interfemoral membrane, its posterior border ciliated but less thickly so than in *M. nattereri*. The forearm measures about 40 mm., the foot about 9 mm. The middle upper premolar is exceptionally small and slender, and scarcely rises above the flesh in which it is imbedded.]

[THE MOUSE-EARED BAT.

MYOTIS MYOSOTIS (Bechstein).

The Mouse-eared Bat was hesitatingly included by Bell in the British fauna on the strength of specimens supposed to have been taken in the gardens of the British Museum. Since then it has been occasionally reported from other localities, including, as collected by Mr J. E. Harting,[3] Sherborne, Dorset (C. W. Dale), Epping (F. Doubleday), Freshwater, Isle of Wight (Hadfield), and Ireland (Blake Knox): no doubt Mr Harting's expression of misgiving as to the correct determination of the species was not over-cautious.

All the above records are of little, if any, value, and that for the Isle of Wight was expressly contradicted by A. G.

[1] *Faune Belge*, 1842, 20. [2] *Zoologist*, 1856, 4938-4939.
[3] *Ibid.*, 1887, 161-162, footnote.

More.[1] In 1903, however, Mr J. Lewis Bonhote[2] noticed a genuinely British-killed specimen in the University Museum of Cambridge. This was taken at Girton in 1888 by a lady who brought it alive to Dr Hans Gadow.

This species has suffered much at the hands of slipshod nomenclaturists. It is clearly the *Vespertilio myosotis* of Bechstein,[3] and is as certainly the type of Jakob Kaup's genus *Myotis* of 1829, so that there can be no doubt about its correct title, according to modern usages. Unfortunately, however, the majority of continental naturalists, beginning with Schreber in 1775, finding it their commonest or most conspicuous bat, supposed that it must be also the "Common Bat," *Vespertilio murinus* of Linnæus, and thereupon transferred the latter name to it, whereas, as has been already shown (p. 51), the bat thus designated is a very different species. Unfortunately the confusion did not stop at this point, since British naturalists, following the lead of their continental brethren, applied the name *murinus* to the Pipistrelle, the Common Bat of their country.

Considering that this bat is reputed to be one of the most frequent on the European continent, even in those countries, such as Normandy, which are separated from England only by the breadth of the channel, it is very remarkable that it should be unknown as a regular inhabitant of Britain. But it cannot be doubted that Bell was correct in believing that, were it really British, its large size and the comparative ease with which specimens can be obtained, would long since have brought it under notice. Mr Bonhote repeats this argument in regard to the Cambridge example, which, although undoubtedly killed in Britain, must, he thinks, have been brought over accidentally from the continent.

The Mouse-eared Bat, should it occur again in Britain, can hardly be mistaken for any other. In size it is at least the equal of, perhaps superior to, our three largest species, the Noctule, Serotine, and Greater Horseshoe. In form it is rather, however, a large Bechstein's Bat, with relatively smaller

[1] *Zoologist*, 1894, 148. [2] *Ibid.*, 1903, 387.

[3] *Der Zoologe*, v.-viii., 46, 1797, corrected to *V. myotis* by Bechstein, in *Gemeinutzige Naturgeschichte Deutschlands, &c.*, I., ed. 2, 1154, 1801.

ears extending, when laid forward, only just beyond the tip of the muzzle; shorter and roundly triangular, not sickle-shaped, tragus reaching not more than half the height of the ear; and a very small middle upper premolar lying in a position completely interior to the tooth-line.]

GENUS PLECOTUS.

1816. MACROTUS, W. E. Leach, *Systematic Catalogue of the Specimens of the Indigenous Mammalia and Birds that are Preserved in the British Museum*, 1; based on *Macrotus europæus* of Leach, the "European Longear," from Devonshire, England, presented by G. Montagu; named, but without description, hence *Plecotus* has priority.

1818. PLECOTUS, Étienne Geoffroy, *Description des Mammifères qui se trouvent en Égypte*, ii., 112, 118-119, pl. ii., No. 3 (for date see Sherborn, *Proc. Zool. Soc.* (London), 1897, 287-288; based on *l'oreillard* of Daubenton, *la barbastelle*, and an undescribed species from Timor.

1829. PLECAUTUS, François Cuvier, in *Dictionnaire de Sciences Naturelles*, lix., 415, a misprint for *Plecotus;* no species mentioned.

This genus, although small in known species, has a wide **distribution**, mainly in the Palæarctic region, where it ranges from Ireland to Sakhalin, and from about 60° north latitude in Skandinavia to north Africa. There is one British representative, the well-known *P. auritus*. *P. puck*, which I described from Murree, northern India, differs in cranial characters, while my *P. teneriffæ*, from Teneriffe, is larger, having the forearm measuring about 44 mm. (see *Ann. and Mag. Nat. Hist.*, December 1907, 520-521); G. M. Allen's *P. sacrimontis*, from Mt. Fusi-Yama, Japan, has a long thumb (11·7 mm.). Several other specific names have been instituted, but are of unknown value. They are mentioned below on p. 195. In North America it is represented by the closely allied *Corynorhinus*, differing in the shape of the nostril, conspicuously glandular muzzle, and in the proportions of the wing.

Generic characters:—These are bats of medium size, with immense ears (Plate XIV., Fig. 4), meeting by their inner margins on top of the head, the outer margins terminating just behind the angles of the mouth. The tragus is large and elongated.

The muzzle bears the elongated, narrowly crescentic nostrils

at its extremity, in front of deep grooves separating the hairy, flat, and depressed central region from the glandular sides. There is no groove in front of the nostrils.

The **wing** (Plate XVII., Fig. 1) is broad and arises from the base of the toes. The antibrachial membrane is well developed. The fifth metacarpal is a little shorter than the third and fourth.

The calcar extends about half-way from foot to tail. There is no post-calcarial lobe. The tail is almost as long as the head and body, and has the tip slightly exserted.

The **skull** (Fig. 8, No. 4, p. 101) is weak; the profile descends gradually from the inflated brain-case to the depressed, broad, not saddle-shaped facial region; the zygomata are flattened; the cranial crests are very slightly developed; the auditory bullæ are very large, fully equalling, or, perhaps, exceeding, in size those of much larger bats, such as *Nyctalus noctula*, *Vespertilio serotinus* or *Myotis myosotis*.

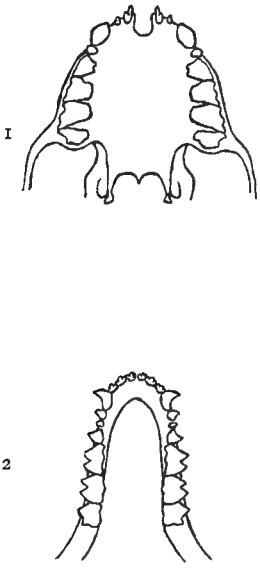


FIG. 19.—DIAGRAM OF ARRANGEMENT OF TEETH IN GENUS *Plecotus*.

(1) Upper and (2) Lower Jaw.

There are two less **teeth** (Fig. 8, No. 4, p. 101; Fig. 19; and Fig. 20, p. 197) than in *Myotis*, one pair of upper premolars being absent; two more than in *Barbastella*, the formula being:—

$$i\ \frac{2-2}{3-3},\quad c\ \frac{1-1}{1-1},\quad pm\ \frac{2-2}{3-3},\quad m\ \frac{3-3}{3-3} = 36.$$

The upper incisors point directly inwards; the inner is bifid, with inner cusps much exceeding the outer; the outer is smaller and unicuspid. The canine is without accessory cusps. The anterior upper premolar, although small, is distinctly visible externally. The posterior upper premolar is large. The three lower premolars graduate in size from the posterior to the central, which is smallest.

THE LONG-EARED BAT.

PLECOTUS AURITUS (Linnæus).

1740. THE DOUBLE-EARED BAT, Eleazar Albin, *A Natural History of Birds*, iii., 95, pl. ci.

1758. VESPERTILIO AURITUS, Carolus Linnæus, *Systema Naturæ*, x., 32 (6); xii., 47 (5), 1766; described from Upsala, Sweden; Bingley; Donovan; Jenyns; Clermont.

1789. (?) VESPERTILIO AURIBUS, Gilbert White, *Selborne*, Letter xi. to Thos. Pennant, 9th September 1767; named, but without description, from Selborne, England.

1816. (?) MACROTUS EUROPÆUS, W. E. Leach, *Systematic Catalogue of the Specimens of the Indigenous Mammalia and Birds that are Preserved in the British Museum, etc.* (London), 1; named, but without description, from Devonshire, England, from Montagu's specimens.

1818. PLECOTUS AURITUS, Étienne Geoffroy, *Description des Mammifères qui se trouvent en Égypte*, ii., 118, pl. ii., No. 3; Fleming; Bell (ed. 1); MacGillivray; Blasius; Fatio; Dobson; Blanford; Flower and Lydekker; Lydekker; Thomas; Méhely; Johnston; Cabrera; Millais; Trouessart (1910).

1825. VESPERTILIO OTUS, Friedrich Boie, *Oken's Isis* (Jena), ii., 11, 1206; described from Copenhagen, Denmark.

1826. VESPERTILIO CORNUTUS, —— Faber, *Journ. cit.*, i., 5, 515; described from Horsens, Jutland, Denmark.

1827. PLECOTUS COMMUNIS, R. P. Lesson, *Manuel de Mammalogie*, 95, No. 232.

1827. PLECOTUS CORNUTUS, *auct. et op. cit.*, 96, No. 234.

1828. PLECOTUS BREVIMANUS, Leonard Jenyns, *Trans. Linnean Soc.* (London), xvi., 55, pl. i., fig. 2; described from an immature specimen from Grunty Fen, Isle of Ely, England; not *P. brevimanus* of Bonaparte, 1841; Bell, eds. 1 and 2 (figures).

1829. PLECOTUS VULGARIS, A. G. Desmarest, *Faune Français, Mammifères*, livr. 19, 18; pl. 2, livr. 16, fig. 3, described from France.

1829. VESPERTILIO BREVIMANUS, J. B. Fischer, *Synopsis Mammalium*, 118 and 553.

1832. P. PERONII, Isidore Geoffroy, Guerin's *Magasin de Zoologie*, ii., Classe I., No. 2, pl. iii., fig. 1; described from a male and female obtained, locality unknown, during the voyage of Péron and Lesueur.

1860. PLECOTUS KIRSCHBAUMII, Carl Koch, *Achter Bericht der Oberhessischen Gesellschaft für Natur- und Heilkunde*, 40; described from Oberhessen, Germany.

1862-63. PLECOTUS AURITUS, TYPUS, MONTANUS ET BREVIPES, Carl Koch, *Jahrbücher des Vereins für Naturkunde im Herzogthum* (Nassau), 406-408; described from Nassau, Germany.

1873. PLECOTUS LEUCOPHÆUS, N. A. Syevertzoff, *Trans. Soc. Nat. Moscow*, viii., 2; translated by Craemer in *Ann. Mag. Nat. Hist.*, July 1876, 42: named, without description, from north-western Turkestan.

L'Oreillard[1] of the French, *die langöhrige Fledermaus* of the Germans.

Distribution:—The Long-eared Bat ranges throughout boreal and transitional into tropical Europe and Asia, from sea-level to about 6500 feet in the Caucasus (Satunin); from 60° N. latitude in Skandinavia and Russia (Blasius) to north Africa, including Tunis[2]

[1] Horned Bat, of Cheshire (Coward and Oldham); see also under PIPISTRELLE, p. 105.

[2] Specimens seen.

and Egypt at least to the fifth Cataract (Bell); and from Ireland to Palestine (Tristram) and Hokkaido, Japan.[1] Its area of distribution includes the Islands Malta,[1] Sicily (Dobson), Minorca and Ibiza (Cabrera; Barceló). Specimens from more than one locality have formed the basis of specific names, e.g., *bonapartii* of Gray (*Mag. Zool. and Bot.*, ii., 495, 1838) from Sicily; *ægyptiacus* of Geoffroy from Egypt;[2] *christii* of Gray (*loc. cit.*) and *ustus* of Heuglin, from Wadi Halfa, north Africa; and *homochrous* of Hodgson (*Journ. Asiatic Soc.*, Bengal, XVI., ii., 894, 1847) from the central sub-Himalayas. The status of these forms, if indeed they be distinct from typical *auritus*, is quite unknown.

The Long-eared Bat is probably one of the commonest, if not the commonest, and most widely distributed in Britain, but its habits necessarily render it less conspicuous than many others. It is certainly to be found everywhere in **England**, including the Isles of Wight (More; Bury, *Zoologist*, 1844, 777; Wadham), and Scilly (Clark), and almost with equal certainty in every county of **Wales** (see Forrest, *Trans. Caradoc and Severn Valley Field Club*, 1900, 242). It is common in all the Channel Islands (Bunting).

In **Scotland** there are so many records of its abundant occurrence in the low-lying southern, central, and eastern counties to the Moray Firth, that this part of the country may probably be reckoned with England and Wales. Service, for instance, believes that in Solway it "is much the most abundant [bat] that we have," and in Aberdeen it is stated to be commoner than the Pipistrelle (Sim; Kinnear). In the highlands it becomes rarer, but details are, as a rule, lacking for areas north of the Caledonian Canal. Its range may, however, include the extreme north, since Eagle Clarke has a note from a correspondent that in west Inverness, north-west of Fort William, it outnumbers all others, and Sir Joseph Fayrer found it in Sutherland (Dobson, *Report British Association*, Swansea, 1880, 183). W. Evans cites an out-of-the-way locality in rocks at Dumglow, Cleish Hills, Kinross-shire (*Proc. Roy. Phys. Soc.* (Edinburgh), xvi., No. 8, 388, 27th November 1905). In the islands it is known from Arran and Mull (Alston), Islay (Alston; Gilmour, *Ann. Scott. Nat. Hist.*, 1897, 191), and North Uist (Millais), which facts suggest a wide distribution.

It is included by Kermode (*Zoologist*, 1893, 62) in the Isle of Man fauna, but is stated to be not so common there as *Pipistrellus pipistrellus*.

In **Ireland** it is probably found commonly in every county, having been known to Alcock and Moffat from all except eleven (*Irish Naturalist*, 1901, 250-1), and there can be but little doubt that the

[1] Specimens seen.

[2] Or *ægyptius*, as frequently cited, but original description not found.

vacancies represent rather lack of observers than of the bat. It has been taken on such desolate western islets as the Tearaght, Co. Kerry, on 4th November 1901 (Barrington, *Migration*, 284), and by Sheridan on Achill, Co. Mayo (Dublin Museum).

Distribution in time:—A portion of a humerus from layer 11 of the Pleistocene deposits of Hoe Grange Cavern, Derbyshire, has been doubtfully referred to this species by Arnold Bembrose and E. T. Newton (*Quart. Journ. Geol. Soc.*, 28th February 1905, 50).

The **period of gestation** is unknown. The **number of young** is one, born most usually in June or July.

Description:—The general form and appearance are typically those of its genus.

The **head** (Plate XIV., Fig. 4) is only slightly raised above the face-line; the muzzle rather long and prominent, horizontal, and slightly emarginate; the nostril with prominent edges, the opening lateral, passing backwards and outwards into a distinct groove. The **ear** is so large as to almost equal in length the entire head and body. It is oval, oblong, semi-transparent, and transversely folded. The inner margin is bent outwards, and forms a broad longitudinal fold, ciliated at its edge as well as along the keel formed by the bending. Immediately above the point where the two ears meet, their margins form an angular notch; above this, on each side, a small lobe projects laterally, so that when the ears are erect it touches its fellow; these lobes are hairy, thicker, and more opaque than the rest of the ear. The tragus is elongate, lanceolate, rather obtuse, bending very slightly outwards, and having a length about two-fifths that of the whole ear. The conspicuous eye is placed slightly in front of the inner angle of the base of the tragus.

In the **wing** (Plate XVII., Fig. 1) the interfemoral membrane is conspicuous, and is supported by a remarkably long tail and lower legs. The foot is also large, but the calcar, although strong, is not of exceptional length. It terminates in a distinct lobe.

The **fur** is rather long, soft, thick, and silky; its abundance on the shoulders gives the body a broad appearance. On the wing it extends about as far as lines joining the centres of humerus and lower leg. The ear, except for fringes on the folds, is almost hairless. The foot is ciliated.

The **colour** is, above some shade between "wood brown" and "broccoli brown," below dirty white or yellowish. The basal portions of the hairs are everywhere dusky. The line of demarcation follows the wing and thence to the angle of the mouth, but is not very clearly marked. According to Bell, young specimens are redder, old ones greyer; but Dobson thought the young and females darker dorsally.

I have seen no evidence of **seasonal variation.**

The **skull** and **teeth** are typical of the genus.

Individual variation manifests itself not infrequently in albinism, partial or complete. White or "albino" varieties (the colour of the eyes not stated) are mentioned by Newman, *Field*, 21st March 1874, 271; Borrer, *Zoologist*, 1874, 4128 (two); Baring, *Journ. cit.*, 1898, 261. I have also records of one with the foreparts paler than usual (Bury, *Journ. cit.*, 1844, 777); a buff one (in Dublin Museum of Science and Art), and one of a uniform cream colour, with pink eyes and nails (Oldham, *Journ. cit.*, 1890, 349). Millais has seen a true albino and a cream-coloured variety from Norfolk, and Eagle Clarke (*Naturalist*, 1894, 68) mentions a melanic one.

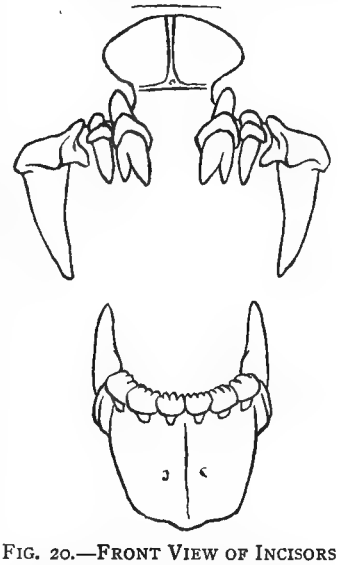


FIG. 20.—FRONT VIEW OF INCISORS AND CANINES OF *Plecotus auritus* (enlarged and diagrammatic).

The extent of **geographical variation** is quite unknown. Cross-channel specimens resemble British, but Hungarian and central European average larger and are lighter in colour, with apparently larger ear and smaller foot, and may possibly represent a hitherto undescribed subspecies. Those from Africa and others from sandy regions are said to be of pallid coloration (? *P. christii* of Gray), while Hodgson's *P. homochrous* from the Himalayas has a larger ear and smaller thumb. Specimens from Tor, Sinai, Ladak, and Hokkaido appear to be of the latter form. For local English difference, see Whitaker, *Naturalist*, 1910, 422.

Dimensions:—The female appears to have slightly the larger wing.

Proportionate lengths:—Foot (without claws), about ·48 to ·50 of lower leg; fifth metacarpal, about ·95 to ·96 of third; lower leg, about ·47 of forearm, and about ·35 to ·40 of head and body; ear, about ·74 to ·77 of head and body, and about ·96 of forearm.

Skull:—Greatest length, 16·5; basal length in middle line, 12; palatal length in middle line, 7; from posterior border of m^3 to anterior border of canine, 5; same in lower jaw, 6; greatest breadth at zygoma, 9; posterior breadth, 7; breadth at constriction, 4.

Weight:—Charbonnier sends me the weight of a female as 2 drams 21 grains, or about 5 grammes.

Distinguishing characters:—The enormous ears, united at their bases in front, are a unique feature of this species amongst British mammals.

DIMENSIONS IN MILLIMETRES:—

	Head and body.	Ear, greatest length.	Tragus, greatest length.	Tail.	Lower leg.	Hind foot, without claws.	Forearm.	Thumb, without claw.	Longest digit.	Metacarpal III.	Metacarpal V.	Greatest expanse of wings.	Weight.
Males.													
Male, Grimsby, Lincolnshire, 10th Sept. 1890 (W. Eagle Clarke)	47	35·5	18·25	43·5	..	..	38	..	..	..	..	259*	..
Male, Manifold Valley, North Staffordshire, 16th March 1907 (C. Oldham)	47	34·5	16	35	19	8·5	36	7	63	31	30	247	..
Male, Tring, Herts, dried skin at British Museum	51	36	..	45	17	9	37·75	5·5	62	31·5	30	..	..
Male, London, do.	51	38	..	48	17	9	37·5	6	63	31·5	31	..	..
Male, Montrose, do.	45	36	..	45	16·5	8·5	37·75	7	63	31	30·5	..	..
Male (dried skin), Co. Louth, 3rd August 1893 (Dublin Museum)	..	..		..	18	9	38	7·25	64	32	30·25	..	..
Male (do.), do. 4th August 1893 (Dublin Museum)	..	..	..	..	17	9	37	7	62·75	31·75	30	..	..
Male (do.) do. 5th August 1893 (Dublin Museum)	..	..	..	33·5	17	9	39	7·5	62·5	32	31	..	..
Male, Achill Island (do.)	..	..	..	..	16·25	8·5	35	6	57·75	29·25	27·75	..	..
Male (in the flesh), Co. Fermanagh (do.)	..	..	..	..	18	9	39	7	62·5	32	29·5	..	..
Average of males (approximate)	48·2	36	..	41·6	17·3	8·8	37·5	6·6	62·2	31·3	30	..	..
Male, young, Devon	50	37	..	44	17	9	..	..	..	..	..	..	..
Male (dried skin), Co. Louth (hardly mature)	..	..	..	..	18	9	38·5	7	61	31	29	..	..
Male, young, Co. Antrim (Dublin Museum, in alcohol)	..	..	..	..	11	8	32·5	7·5	27·5	14·5	13	..	..
Females.													
Female (in flesh), Manifold Valley, Staffordshire, 16th March 1907 (C. Oldham)	46	36	17	40·5	19	8	40	8	66	33	31	256	..
Female, Devon, dried skin, at Brit. Museum	48	35	..	42	17·5	9	37	7	61·75	30·25	29·75	..	..
Female, Essex, do.	42	36	..	45	18	9·5	39·5	6·5	65	33	32	..	..
Female, Herts, do.	49	35	..	42	18·5	8·5	39	6·5	65	32	31·5	..	.
Female (1), Montrose, do.	46	34	..	46	18	9·5	40·5	6·5	68	34	32·5	..	..
Female (2), do. do.	45	..	..	42	18·5	8	40	6	67	33	31·5	..	..
Female (3), do. do.	44	..	..	40	17·5	8	38	7	63	31	29·5	..	..
Female, North Berwick, 16th Sept. 1894 (W. Eagle Clarke)	46	35·5	15	46·5	18	10	38·5	7·5	..	..	..	260	5 grms.
Female (dried skin), Co. Louth, 5th July 1893	..	..	..	37	17	10	38	7	63	32	30·5	..	..
Female (do.) do. 5th August 1893 (Dublin Museum)	..	..	..	41	17	9	(!)35·5	7	64	32	31·5	..	..
Female (do.) Co. Armagh, 4th September 1893 (Dublin Museum)	..	..	..	..	18	9	39	7	63	32	30	..	..
Female (from spirit), Co. Louth (Dublin Museum)	..	..	..	..	19·75	8	40·25	7·5	67·5	33	31·5	..	..
Female do.	..	..	..	..	19	8·5	38	7·5	64	31	30·25	..	..
Female do.	..	..	..	..	18·5	9	38·5	8·5	64·5	32	30	..	..
Female, Co. Meath (do.)	..	..	..	..	19	9	39	8	66·5	31·5	31	..	..
Female, Co. Dublin (do.)	..	..	..	..	20	9	40	7	66·5	33	32·25	..	..
Female, Co. Louth (do.)	..	..	..	..	19	9·25	40	8	65·5	32	31	..	..
Average of females (approximate)	45·7	35·2	..	42·2	18·3	8·8	38·8	7·1	65	32	30·9	..	..

* Average total expanse of eight individuals, 225.

Few creatures have been more persistently misrepresented by writers of books than this beautiful and abundant bat. Although figured by Albin in 1740, and known to Gilbert White at least as early as 1767, it met with very scanty treatment in the works of our earlier naturalists, such as Pennant and Donovan. Bingley alone described its habits at any length, although, like his contemporaries, he fell into the picturesque error, supposed to have originated with Edwards, that the lesser ear may possibly serve as a valve to close the larger in the sleeping state of the animal. It was not until Messrs N. H. Alcock and C. B. Moffat[1] undertook to write its natural history that an adequate account of it from first-hand study became available.

The large and beautiful ears are developed to such an extraordinary degree as at once to strike the most incurious observer, and yet probably their actual comparative magnitude is not fully recognised. But it needed not the unnecessarily cruel experiments of certain foreign naturalists[2] to show that they must have some intimate connection with the animal's safe progress by night through the arboreal obstacles amongst which it delights to wander, but whether as organs, directly tactile or merely sensory, has not been exactly ascertained.

The ears are usually folded[3] under the arms during sleep, especially if the sleep be profound, and this is also the case during hibernation; the long traguses then stand up, and the animal has the appearance of having short and slender ears. Indeed, a person who had not seen it in the act of folding its ears, would never imagine it to be the same species when they are fully expanded. At other times they fold outwards and sideways almost like the horns of a ram, the traguses in this case reflexed. They frequently move independently in a curious manner, a bat in an attitude wherein one ear projects forwards and the other is folded beneath its arm, being a somewhat remarkable object. In flight the ears are directed forwards.

A great preponderance of observers have testified that this bat is one of the most arboreal species, and not, as

[1] *Irish Naturalist*, 1901, 241-251. [2] See Introduction, pages 40, &c.
[3] The folding is well described by A. H. Cocks, Buckingham.

R. F. Tomes supposed, an inhabitant of the open country. It frequently seeks its prey, somewhat after the fashion of the Whiskered Bat, amidst the intricacies of the branches, where it plucks, snaps, and snatches insects of all kinds from the leaves.

Among the first to detect it in the very act of thus hunting was Tomes, who observed a bat of this species actively engaged around the sprigs of a spindle tree which extended across a window. The tree was in bloom at the time, and was surrounded by a cloud of micro-lepidoptera, on which the bat was feeding at a distance of scarcely four feet from the open window, so that it was easy to see the whole proceeding, and to determine with certainty the manner in which the food was taken. With scarcely an exception the moths were picked from the leaves while resting there, only one or two being taken on the wing. While thus occupied, the bat hovered much after the manner of the kestrel, and the ears were bent outwards so much as to curl down the sides of the face; they thus suggested two large cheek-pouches rather than ears, no part of them appearing at a greater elevation than the crown of the head. This could be noted very accurately, as the creature several times hovered scarcely a yard from the face of the observer at the open window, as if desirous of entering. This it afterwards did, and after flying round the room a few times, returned to its feeding.

Similar observations had been made by Jonathan Couch,[1] who, in broad daylight, happened to see one taking something from the surface of a leaf; he imagined that the long ears might act as organs of quick sensation, as the bat flies amongst leaves which stand thick on a tree.

Again, Mr G. H. Caton Haigh[2] has watched it in a group of silver-fir trees, which on warm nights in April "appeared full of bats, sometimes flying with the greatest rapidity through the branches and sometimes hovering like great moths at the extremity of the twigs. On going underneath the trees the bats presented a still more curious sight: generally upwards of a score might be seen moving about in the space of a few feet. They appeared frequently to come in contact with the branches,

[1] *Zoologist*, 1853, 3937. [2] *Ibid.*, 1887, 294.

but whether by accident or not" he was unable to ascertain. One which he shot at this place had a small leaf of the silver-fir in its mouth.

Nowhere are these bats more in their element than when in April the flowering sallows are the centre of a crowd of moths attracted by the blooms. Round these Mr J. Steele Elliot[1] has watched them circling, and when moths attracted their attention, they would steady themselves in their flight, and with quivering wings (which sometimes gave him the impression that they were perching), would seize their prey, frequently from off the bloom itself. So, too, Mr William Jeffery[2] has observed them taking moths off the blossoms, "the bat closing its wings, folding down the ears, and making its meal there and then without quitting the tree." The above description represents the more normal habits of the species, but it is nothing loth to catch its prey in full and open flight, gracefully swooping upon the larger moths as Mr Peter Inchbald has observed.[3]

The bats are wont to vary the activity of insect-hunting by retirement with their prey to the seclusion of some barn or outhouse, where the rejected wings of their victims falling to the floor often betray their presence.[4] Mr O. V. Aplin[5] remarks that these retreats are not sleeping-places but merely dining-halls, and in the neighbourhood of Banbury the moths most extensively captured are the buff ermine,[6] yellow underwing,[7] and silver Y.[8] Where no better dining-hall is available, the bat is perforce content with such lowly sites as a tree-trunk, where Mr J. Ffolliott Darling[9] has observed one, after catching insects, sit munching a large moth so vigorously that he could hear the crackling of the moth's armour as it disappeared.

Messrs Alcock and Moffat find that in County Wexford the tree most frequently selected for a hunting-ground is the ash, amongst the branches of which it may be seen every evening from May to September. In early May they

[1] *Zoologist*, 1897, 231.
[2] *Ibid.*, 1890, 71.
[3] *Field*, 23rd July 1887, 149.
[4] Lord Lilford, *Zoologist*, 1887, 66.
[5] *Zoologist*, 1889, 382.
[6] *Spilosoma lubricipeda*.
[7] *Triphæna*.
[8] *Plusia gamma*.
[9] *Zoologist*, 1883, 294.

have found it also in the oak-woods. But trees are not by any means an absolute necessity to it, for it will also hunt low over the ground, probably in search of grass-loving insects, and it has been hooked in the mouth by the Hon. R. E. Dillon when fishing with an artificial fly.[1] It appears to be a jealous little creature, for it has often been seen to attack and repulse a Pipistrelle whenever one chanced to approach its feeding-grounds.

"To observe this bat on the wing," write these observers,[2] "it is a good plan to wait at dusk under some tree whose foliage is not too dense to be seen through—an Ash is probably the best that can be selected—and watch for its appearance amongst the branches overhead. From about thirty-two or thirty-five minutes after sunset, its figure may, almost any summer evening, be thus detected against the sky, gliding and hovering in a stealthy manner among the outer sprays of the tree. It threads its way with a beautiful facility among the twigs and leaves, often seeming rather to swim than to fly, so slight is the visible movement of the wings. Poising, at times, like a humming-bird, it appears to be picking something from the leaves; at other times it suddenly plunges into the middle of a spray, and remains for several seconds clinging to the twigs, no doubt securing or eating some insect. It is not uncommon to see one Ash-tree occupied at the same moment by five or six of these bats—though each comes and departs by itself—all gliding in the same noiseless and lemurine fashion among the leaves, and all to the casual bystander practically invisible. The long ears are often thrown forward so as to resemble a proboscis, and may be distinctly seen if the observer is posted immediately below the bat.

"When one of these bats leaves a tree, if its object is merely to pass to another quite near at hand, it darts through the air with a swift arrowy flight; but when a longer expedition is contemplated the mode of quitting the tree is different. The bat plunges headlong to within an inch or two of the ground, and then skims away in jerking zigzag fashion—much as a Nightjar does—over the surface of the field. The swift

[1] The "Detached Olive," *Irish Naturalist*, 1906, 278.
[2] *Ibid.*, 1901, 242-244.

plunging descent taken on these occasions is very remarkable, and renders it a difficult matter to keep the animal longer in sight. . . .

"This bat is decidedly later than the Hairy-armed[1] in appearing on the wing. In August, 1900, the time of its first appearance about a favourite Ash-tree was noted on nine consecutive evenings, with the following result :—

August	4th.	Long-eared Bat	first seen	26	minutes	after sunset.
„	5th	„	„	36	„	„
„	6th	„	„	36	„	„
„	7th	„	„	33	„	„
„	8th	„	„	34	„	„
„	9th	„	„	32	„	„
„	10th	„	„	33	„	„
„	11th	„	„	37	„	„
„	12th	„	„	34	„	„

Thus, in eight evenings out of nine the first appearance was between thirty-two and thirty-seven minutes after sunset."

That the flight of the Long-eared Bat extends throughout the night, was suggested by Tomes, who, as stated above, not only observed it feeding at three o'clock in the morning, but heard the shrill chatter of its easily recognised voice over his head at all hours of the night, even the darkest, in the open fields and elsewhere. Confirming this statement, Mr Inchbald[2] writes that he has watched this species catching moths between 2 and 3 A.M. in July, and Messrs Alcock and Moffat state that it has been identified on the wing in County Wexford in the third week of August, at midnight, at 1.30 A.M., and in the morning twilight.[3] At each of the earlier hours the identification was effected by watching a bat flying in and out of a conservatory, where it was possible to identify it with certainty. The same writers suggest that this bat seeks its diurnal hiding-places while the morning light is still dim, never having observed it in view later than forty-five minutes before sunrise.

The hibernation of the Long-eared Bat appears to be both more profound and of longer duration than that of some other

[1] *I.e.*, Leisler's Bat.

[2] *Field*, 23rd July 1887, 149.

[3] Gordon Dalgliesh met with one on the wing at midnight on 1st December (*Zoologist*, 1908, 178).

species, but there is a dearth of precise data, and those available are contradictory. In Buckinghamshire Mr Cocks has obtained specimens in nearly every month of the year. In Wales it has been observed on the wing, on each occasion in sunshine, on 18th March and 4th November,[1] and Mr T. W. Proger once saw one come out and drink at a fountain in December[2]: in County Wexford it has not been detected flying earlier than the 13th April, while in autumn it ceases to frequent its favourite ash-trees in mid-October, yet is repeatedly captured in November. But, as remarked by Messrs Alcock and Moffat, these observations prove little more than that certain bats were abroad on the dates stated, for the winter sleep is liable to be broken by a moderate degree of warmth. They write:—

"On December 21st, 1900, a bat of this species was found hibernating at Ballyhyland, in a convenient position for observation *in situ*. The sleeping-place was a hole in a Beech-tree, $5\frac{1}{2}$ feet above the ground. On the insertion of a finger, the Bat snarled savagely enough; but when let alone it soon relapsed into an apparently profound slumber.

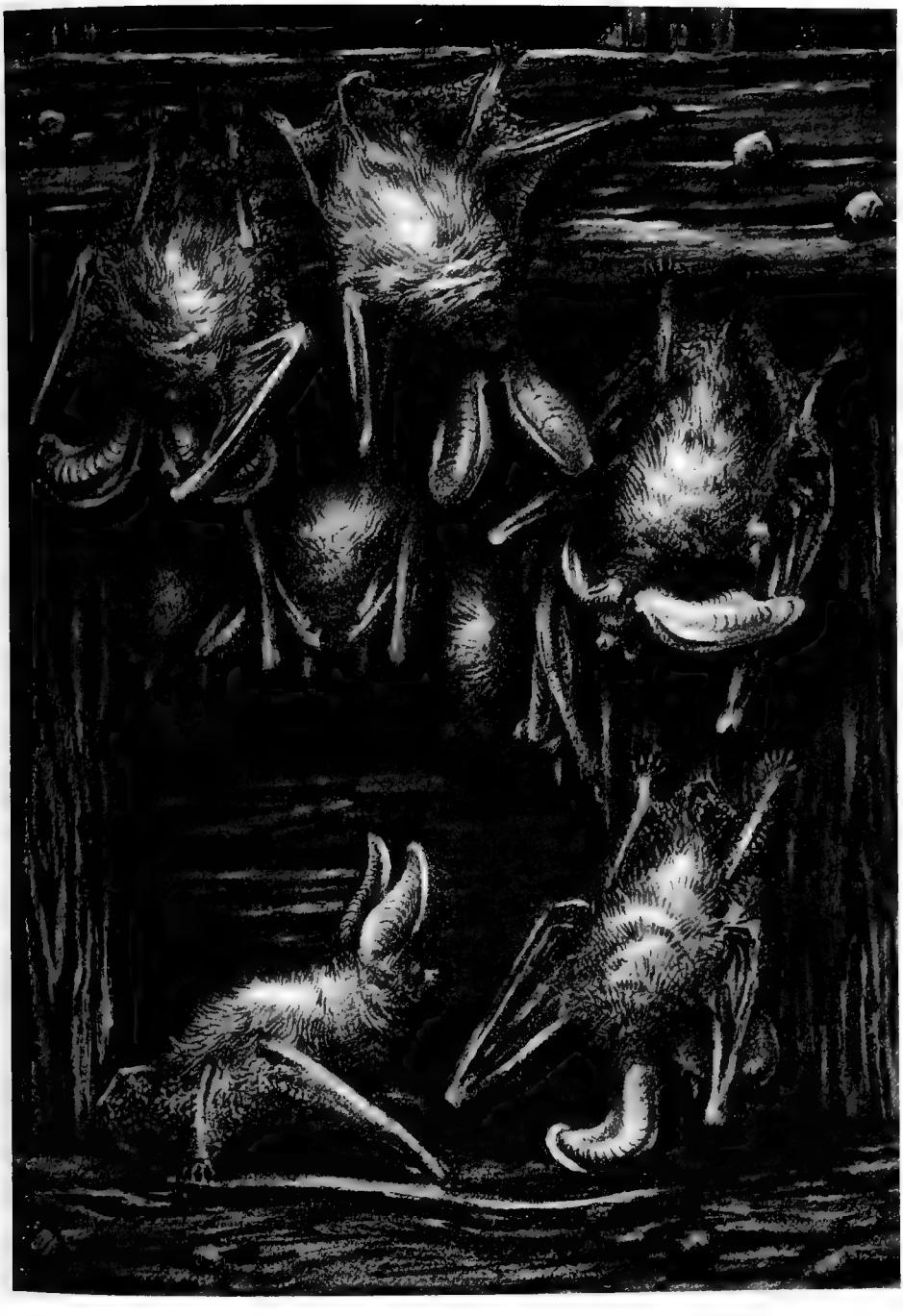
"On the next day (22nd December) it was gone, having evidently flown during the night. This desertion must in fairness be ascribed to its having been disturbed, and slightly alarmed, on the previous afternoon. The remainder of December, and the first two nights of the ensuing January, were characterised by cold and frost, and during this period the hole continued unoccupied.

"The night of January 3rd was mild; the thermometer until nearly midnight remained at 46°, and the Pipistrelle was seen flying. On the morning of the following day the Long-eared Bat was found to have returned to its hole in the Beech-tree.

"For about three weeks from the above date this Bat was looked at every day, and often with a lantern during the night. From January 4th to 11th the observer detected no change of attitude; but on some of these days, when the temperature was as high as 44°, the little creature fidgeted slightly during sleep. On January 12th, at a temperature of 46°, it became very rest-

[1] H. E. Forest in MSS.

[2] Paper read before the Biological and Geological Section of the Cardiff Naturalists' Society, March 1905, 4.



LONG-EARED BATS. ($\frac{2}{3}$ natural size.)

less, and after sunset crept out of its hole and sat for about three hours in an exposed position on the trunk, with its eyes open, but its ears still folded back beneath its wings. A high wind was blowing, which probably prevented the bat taking flight. On the following night—during a great storm, and at a temperature of 49°—the animal was again found outside its hole, this time with one of its ears unfolded and protruded in front of it, while the other was still tucked below the wing. Though the bat's eyes were wide open, and it seemed in attitude ready to fly, it manifested no concern at having the lantern held over it. Flight in such a storm would at any rate have been impossible, and before 9 p.m. it was back in its hole. During the next seven evenings it was invariably found asleep in its den at whatever hour visited; and on the night of the 21st of January it was still there at 6 p.m., one and a half hours after sunset, though the temperature was high (51°) and the wind light. Next day, however, the hole was empty. A long spell of cold weather immediately set in, and the bat was not seen again until March.

"It returned for a few days about March 17th, during the observer's absence from the locality, and deserted again on the 25th. On April 10th it was once more in possession.

"By this period of the spring one might have supposed that its hibernation was over; but the Bat's conduct proves the reverse, for during the next three nights—April 10th, 11th, and 12th—it did not fly at all. On the 10th it was visited with a lantern at 7.35, 9.5, and 11.5 p.m.; on the 11th, at 8.45 p.m., and on the 12th, at 8 and 10.30 p.m.; and on all these occasions was seen sound asleep. On the evening of April 13th, however, it quitted the hole at 7.45 p.m. and did not again return. On the same night, as already noticed, a bat of this species—probably not the same individual—was seen flitting round a willow.

"The respective temperatures for the four nights of April 10th to 13th, taken about 8 p.m., were 43°, 41°, 43°, and 45°.

"Other observers have recorded similar facts. Mr C. Oldham[1] informs us that he has found individuals of this

[1] See also *Mem. and Proc. Manchester Literary and Philosoph. Soc.*, 49, ii., 9, 1-4, 31st March 1905.

species in winter in the caves at Alderley Edge, and that these repeatedly shift their quarters. Many similar instances can be adduced, so that hibernation in the case of the Long-eared Bat, at any rate, is not as profound or as unbroken as was at one time supposed, but is repeatedly interrupted; and, apparently, this is liable to occur whenever the thermometer rises above 46° F."

The retreat of the Long-eared Bat is frequently beneath the roofs of tiled houses in villages or towns, in which places they may be found in summer—males, females and young—suspended in clusters[1] from the timbers, and during the winter closely packed between the tiles or in holes, so that unquestionably the same haunts are occupied throughout the year. But, as related above, solitary specimens, the cause of whose lack of sociability is unknown, may be found in their own private dens in winter and spring—in one case instanced by Messrs Alcock and Moffat so late as 2nd May. In fact, Mr Charles Oldham goes so far as to inform me that in his experience solitary hibernation is the almost invariable rule, at least as regards the copper-mine tunnels of Alderley Edge, Cheshire, and the old lead-workings in the Derbyshire dales; whilst in the Henley-on-Thames cavern, Mr A. H. Cocks and Dr E. A. Wilson[2] found five, all resting singly, on 14th February.

An interesting feature in the animal's economy is its habit of appearing for a brief season in summer in colonies or "swarms" in certain places to which it is at other times a stranger. These gatherings, to quote again Messrs Alcock and Moffat, "seldom remain more than a few weeks. In two consecutive years, 1898-1899, a space between the woodwork and wall of the farm-stable at Ballyhyland was occupied by a swarm . . . during the first fortnight of August, which disappeared soon after the middle of the month. In the second year of their visit (1899) particular pains were taken not to disturb them, but by August 20th none remained. In August, 1900, there was a swarm over the doorway of a neighbouring forge, of which not a trace could be found in September; and in July, 1901,

[1] Compare Goldsmith's "Lazy bats in drowsy clusters cling." [2] In lit.

a smaller assemblage took possession for one or two days only, of a space between two beams in the roof of an old mill. This last-mentioned swarm probably consisted of females, with new-born young; for an infant specimen, with eyes unopened, was found on July 11th crawling on the floor immediately below the crevice in which the adult Bats were at the time visible." Since these swarms are so much more frequently noticed in July and August than at other seasons; and since there is evidence, as in the instance last quoted, that they are not composed exclusively of the young of the year, Messrs Alcock and Moffat are led to infer that the social instincts of this species are strongest in summer, and that individuals which have lived solitary lives for the rest of the year become at that season gregarious. It is probable, however, that this "swarming" is in some ways comparable to the "camping-out" for nursing purposes of the Noctule in summer, and it is reasonable to suppose that, as in other bats, a seasonal change of quarters is habitual. Mr Oldham finds the Cheshire and Derbyshire tunnels tenanted only during winter, and the same remark, although not of invariable application, appears to be true also of the Henley cavern.

The cry of this species, although not loud, is shrill and acute, but it is uttered with more vigour when the animal is annoyed. Messrs Alcock and Moffat find it in use by the young when only a few days old, and Mr J. G. Millais graphically dwells upon the considerable variation to which it can be subjected, remarking that "one call is uttered when signalling to its own species, and apparently the same note is uttered during a quarrel; but a very different cry—a querulous, long-drawn, childlike note—is used when it is handled or surprised."

The Long-eared Bat gives birth to its young in June or July, the number being usually one,[1] but Bingley, on the authority of a Mr Carlisle, incidentally mentions a female flying about with two attached to her body. A French naturalist, Monsieur E. Oliver, informed Monsieur H. Gadeau de Kerville that the young clamber from one mother to another, and are by them indiscriminately carried about and nourished,

[1] R. C. R. Jordan, *Zoologist*, 1843, 75; Alcock and Moffat, *Irish Naturalist*, 1901, 248 (11th July).

but the statement is contrary to the experience of Messrs R. Rollinat and E. L. Trouessart, and needs confirmation.[1]

No bat thrives better in captivity than the Long-eared. It may, without apparent injury to its health, be removed from its natural home in mid-winter when completely lethargic; in fact when in captivity it entirely ceases to hibernate,[2] and, although at first very shy and refusing food if offered in the hand, it will readily capture and devour insects left in its cage, and before long becomes a familiar and trusting companion. When a number are kept together, they exhibit much happiness, and are very playful, their gambols being not the less amusing from their awkwardness. They run over and against each other, pretending to bite, but never harming their companions of the same species; though Bell knew some to exhibit a sad spirit of persecution to an unfortunate Barbastelle which was placed in the same cage with them. They may readily be taught to eat from the hand; and one kept by James Sowerby, when at liberty in the parlour, would fly to anyone who held up a fly towards it, and pitching, would take the insect without hesitation. If the insect were held between the lips, the bat would then settle on its patron's cheek, and take the fly with great gentleness from the mouth; and so far was this familiarity carried, that when one of its friends made a humming noise with the mouth, in imitation of an insect, the bat would search about the lips for the promised dainty.

Mr Oldham informs me that a Long-eared Bat which he had in captivity, when its first grip was insecure, pouched its wriggling prey in the orthodox manner in the interfemoral membrane, but used neither foot nor carpus to adjust its hold: on the other hand, it was frequently its practice to spring off the table and eat its meals in the air as it flew round the room, the crunching of its jaws being then distinctly audible. In nature it probably finds the interfemoral pouch very useful, and Mr J. R. B. Masefield informed Mr Oldham that, being close to these bats when hovering over the sallows, he has seen the tail bent upwards so as to form a receptacle for the insect as it drops. "As you know," he writes, "the sallow

[1] Original not seen: quoted by Rollinat and Trouessart, *vide supra*, p. 36.

[2] J. Armitage, *Naturalist*, Feb. 1905, 39.

feeding *Noctuæ* . . . all drop immediately the flower or bush is touched or shaken, and thus the head of the Bat and the interfemoral pouch form a trap from which the moth cannot escape."[1] Mr William Evans has observed that in flight the tail and interfemoral membrane are not stretched out behind, but curved downwards and forwards at about half their length.

The toilet of Mr Oldham's captives was no less elaborate than that of other species, practically the whole body being licked, scratched, or combed by the aid of one foot, the bat meanwhile hanging suspended by the other. The long ears were bent downwards by the wrists, and thoroughly licked with the tongue.

Mr Oldham's bats slept either suspended by the toes or lying prone upon the floor. He noticed that of one of them, after a few days' confinement, although apparently in good health, had undergone a change in the colour of the wing-membranes from light grey to a dull muddy hue.

Neither in confinement nor when at large does this bat manifest a special regard for any particular kind of food. Many moths, besides those mentioned above by Mr Aplin, the remains of beetles, dipterous flies, in particular the blue-bottle,[2] have been found in its rejectamenta by Professor G. H. Carpenter, while Mr J. E. Harting[3] mentions various moths of the genus *Tæniocampa*, and Mr Jeffery the large spotted-winged crane-fly. Mr Caton Haigh believes that it also takes small caterpillars; Mr J. D. Batten has fed it with grasshoppers in confinement; Mr Oldham with moths[4] and mealworms, and Mr J. Armitage[5] with flies, moths, pupæ, small shreds of beef, and mealworms. He has known one to eat twenty of the latter at a single meal.

Like other species, this bat occasionally appears on the wing in broad daylight,[6] and its activity on such occasions or in mid-winter must be ascribed to the causes already recited. That the species, like most others, is not a creature of unvarying habits, is shown by the capture of one by a lighthouse

[1] *Zoologist*, 1899, 472. [2] *Calliphora erythrocephala*. [3] *Zoologist*, 1889, 245.
[4] *Gonoptera libatrix* and *Scotosia dubitata*. [5] *Naturalist*, 1905, 39.
[6] F. W. L. Ross, *Zoologist*, 1845, 1158; Couch, *Journ. cit.*, 1853, 3942; Lilford, *Journ. cit.*, 1887, 66; Oldham, *Journ. cit.*, 1890, 349; R. Newstead in Coward and Oldham, 1895, 166; W. Evans; Forrest in MS., etc., etc.

keeper at the Tearaght, one of the most desolate and inaccessible of all the Irish islets, some eight miles off the coast of Kerry, at so late a date as 4th November 1891[1]; and Mr J. F. Fortune, light-keeper at Aranmore, off the Donegal coast, wrote me that one made its appearance at his lantern on 24th September 1899.

The Long-eared Bat, once clearly seen either at rest or on the wing, can never be mistaken for any other species. The ears, although approached at a great distance by those of Bechstein's Bat, are unique amongst British mammals.[2]

Genus BARBASTELLA.

1821. Barbastella, J. E. Gray, *London Medical Repository*, xv., 300; based on *Vespertilio barbastellus* of Schreber.

1829. Barbastellus, Jakob Kaup, *System der Europäischen Thierwelt*, i., 96; based on *Vespertilio barbastellus* of Schreber.

1839. Synotus, A. Graf von Keyserling and J. H. Blasius, Wiegmann's *Archiv für Naturgeschichte*, i., 305; based on *Vespertilio barbastellus* of Schreber.

Synonymy:—The earliest generic name known to have been applied to the Barbastelle is certainly *Barbastella* of Gray, a name revived by Mr Miller in 1897 (*Ann. and Mag. Nat. Hist.*, Oct. 1897, 384-385). It clearly antedates both *Barbastellus* and *Synotus*, the former of which has to meet the additional objection that, as pointed out by Dobson (*Catalogue of Chiroptera*, 175, footnote), it was in the first instance applied to a species of *Nyctophilus*.

This small and distinct genus includes only one British species, the Barbastelle, *B. barbastellus*.

The **distribution** is imperfectly known, but extends at least from Skandinavia to Abyssinia, Egypt (Heuglin, *Reise in Nordost Afrika*, ii., 30, 1877), and Arabia, where the local form was named *leucomelas* by Rüppell (*Atlas zur der Reise im nördlichen Afrika*, 73, pl. xxviii. B, 1826); and from Great Britain to Assam, where the representative is Hodgson's *darjelingensis*, a common mountain bat of the Himalayas, ascending

[1] R. M. Barrington, *The Migration of Birds*, 284; R. H. Porter, London, 1900.

[2] Since the above article was written, Oldfield Thomas has described *P. wardi*, a large pale-coloured form, from Leh, Ladak, Kashmir (*Ann. and Mag. Nat. Hist.*, 1911, 209); and *P. ariel*, allied to *P. wardi* but of much darker colour, from Ta-tsien-lu, Szechwan, Western China (*Abst. Zool. Soc.* (London), 7th February 1911, 3).

to at least 8000 feet (Blanford). It is said to have a larger ear and longer forearm (44.5 mm.) than *barbastellus*. Satunin's sub-species *caspica* (forearm about 43 mm.), described from Transcaucasia, is not available for examination. The genus is unknown in America.

The **generic characters** are moderate size; ears not large, their bases united at their inner margins on the forehead, their outer margins encircling the eyes and terminating between them and the upper lips; a well-developed tragus with an attenuated tip.

The short muzzle (Plate XIV., Figs. 2 and 3) has the upper surface naked and nearly flat dorsally, the sides glandular and tumid so as to form a raised border: the nostril is terminal, with a broad shallow groove running across the upper lip.

The moderately broad **wing** (Plate XVII., Fig. 2) arises from the base of the toes. The calcar extends about half-way from foot to tail. The post-calcarial lobe is narrow and inconspicuous. The tail is nearly as long as the head and body; its tip projects about 3 mm. from the interfemoral membrane, which is ample, supported by long lower legs, and extends triangularly to some distance behind the feeble feet.

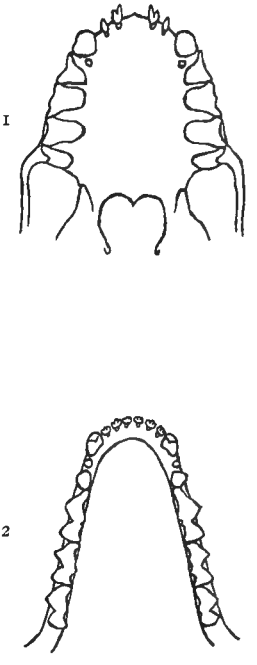


FIG. 21.—DIAGRAM OF ARRANGEMENT OF TEETH IN GENUS *Barbastella*.
(1) Upper and (2) Lower Jaw.

The **skull** (Fig. 8, No. 5, p. 101), as exemplified by *B. barbastellus*, is weak, with prominent rounded brain-case; broad, somewhat concave facial region; weak, flattened zygomata; weak or no cranial crests; and moderately developed auditory bullæ.

There are thirty-four **teeth** (Figs. 21 and 22) arranged as—

$$i\,\frac{2-2}{3-3},\quad c\,\frac{1-1}{1-1},\quad pm\,\frac{2-2}{2-2},\quad m\,\frac{3-3}{3-3}=34.$$

The upper incisors are oblique, the outer pair small, the inner large and bifid; the upper canine is provided with small anterior

and posterior cusps at its base. The anterior upper premolar is minute, and, lying in the inner angle between the canine and posterior premolar, is invisible externally. The anterior lower premolar is about half as high and broad as the posterior.

THE BARBASTELLE.

BARBASTELLA BARBASTELLUS (Schreber).

1760. LA BARBASTELLE, L. J. M. Daubenton in E. L. le Clerc, Comte de Buffon's *Histoire Naturelle*, viii., 119 and 130-131, 135-137, pl. xix., fig. 2; described from France.

1774. VESPERTILIO BARBASTELLUS, J. C. D. von Schreber, *Die Säugthiere*, i., pl. lv., 168, evidently naming Daubenton's *La Barbastelle;* James Sowerby, *British Miscellany*, pl. v., 9, 1804-6; George Montagu, *Trans. Linnean Soc.*, London, ix., 171, 1808; Bingley; Pennant; Jenyns; Clermont.

1785. VESPERTILIO BARBASTELLA, P. Boddaert, *Elenchus Animalium*, i., 69.

1821. BARBASTELLA BARBASTELLUS, J. E. Gray, *London Medical Repository*, xv., 300; Miller; Thomas; Collett; Johnston; Millais; Trouessart (1910).

1829. BARBASTELLUS BARBASTELLUS, Jakob Kaup, *System der Europäischen Thierwelt*, i., 96.

1836. PLECOTUS BARBASTELLUS, Georges Cuvier, *Le Règne Animal*, i., 74; Fleming.

1837. BARBASTELLUS DAUBENTONII, Thomas Bell, *British Quadrupeds* (ed. 1), 63; (ed. 2), 81, 1874, renaming Daubenton's *La Barbastelle;* MacGillivray.

1838. BARBASTELLUS COMMUNIS, J. E. Gray, *Mag. Zool. and Bot.*, ii., 495; evidently renaming *V. barbastellus* of Schreber.

1839. SYNOTUS BARBASTELLUS, A. Graf von Keyserling and J. H. Blasius, Wiegmann's *Archiv für Naturgeschichte*, i., 305; Blasius; Fatio; Dobson; Flower and Lydekker; Lydekker; Cabrera.

1900. BARBASTELLA BARBASTELLA, Méhely Lajos, *Monographia Chiropterorum Hungariae*, 131 and 326, pl. v.

Barbastelle from the French *barbastelle* and Italian *barbastello*, from the Latin *barba*, *i.e.*, a beard. There do not appear to be any **local names** for this little-known bat, either in England, France, or Germany.

Distribution:—Barbastelle-like bats range throughout a great part of the boreal and transitional regions of Europe and Asia from southern Skandinavia and middle Russia to middle Spain, and south Italy (Monticelli), the Crimea, and probably North Africa (Dobson); and from England to Tiflis (Satunin). It is not known if *B. barbastellus* is preferably a mountain bat; as is *B. darjelingensis*, to which it gives way somewhere in the East, perhaps in central and eastern Asia, or, according to Satunin, in Transcaspia. Fatio, however, supposed so, having found it at 5000 feet in the valley of Urseren, at the foot of Saint Gothard, Switzerland. Robert took one at 3200 feet at Caterillo, Haute Garonne.

In Britain this bat is unknown from **Scotland, Ireland,** or the **Isle of Man,** and in **England** the records of its occurrence are mainly from the south. Sowerby's first British specimen was taken by Peete at Dartford, Kent, before 1804 (see synonymy), and Bell was indebted to Waring for another from a chalk cavern at Chiselhurst, in the same county; its occurrence there is corroborated by Millais, who, however, believes that it is now rare; and it is also reported, although not recently, from Cornwall (Clark). Montagu (see synonymy) mentioned specimens from both Milton and Kingsbridge, in Devon, thus completing its range across the south of England. Montagu's record has, indeed, been questioned by Gray (*Zoological Journal*, ii., 110, 1826) on the ground that the individual in the British Museum marked by him *barbastellus*, is undoubtedly referable to *Myotis mystacinus*. But this error must have arisen in the labelling and not in identification, since Montagu's description is very full and correct, and, moreover, recent observers confirm the occurrence of the bat in Devon. It was, for instance, reported as "scarce" at Teignmouth by Jordan (*Zoologist*, 1843, 75), while a specimen from Torquay is, as Hollis informs me, in the Exeter Museum (see de Hügel, *Journ. cit.*, 1869, 1768). Thus between Cornwall and Kent the sprinkling of occurrences perhaps indicates a continuous distribution. There are several records for Surrey (Mitford, *Journ. cit.*, 1860, 6953; Millais, 42; Thorburn, *Field*, 19th July, 1902, 142; Dalgliesh, *Zoologist*, 1907, 299; Bucknill and Murray); and Sussex (Borrer, *Zoologist*, 1874, 4128-29; Brazenor, *Journ. cit.*, 1887, 152; Millais, 42); for Hampshire, one or two (Hart and Kelsall); for Wiltshire, one at Salisbury (Blackmore, *Zoologist*, 1869, 1558); for Somerset, a small colony in the roof of Wells Cathedral (Berry in Millais, 43), and a breeding haunt in Mendip Caves (Lewis, *Journ. cit.*, 1906, 69). From Dorset the bat is reported by Borrer once (*Journ. cit.*, 1869, 4128-29), and by Dale as "not common" (*Journ. cit.*, 1887, 234). North of the Thames Valley it is known from Essex, where Doubleday found it not uncommon in Epping Forest (*Journ. cit.*, 1843, 67), and where Laver, writing of the whole county, thinks that, although "not so rare as it is usually believed to be," it cannot be called common; from Middlesex and Oxford Borrer received one each from Hornsey and South Weston respectively (*Journ. cit.*, 1874, 4128); in Hertford, Oldham found one on Berkhampstead Common (*Journ. cit.*, 1908, 391); for Buckingham, Cocks knows of two occurrences, and one in Berkshire; while from Gloucester two specimens came under the notice of Charbonnier (*in lit.*, also see *Journ. cit.*, 1892, 329; Witchell, *Journ. cit.*, 1892, 356): and others were known to Tomes from the Warwick border. Alfred Newton met with it in Suffolk; the elder Gurney, in Norfolk (*Journ. cit.*, 1857, 5420; see also for Suffolk, Rope, *Journ. cit.*, 1891, 347); and in Norfolk Southwell describes it as not rare and generally distributed.

Jenyns knew of its occurrence in Cambridge[1] and Northampton; Lord Lilford in the latter county (*Journ. cit*,. 1894, 187), and in Huntingdon (*Journ. cit.*, 1894, 395); Steele Elliott in Bedford; and Montagu Browne in Leicester (*Journ. cit.*, 1885, 215). Tomes found it not very rare, although by no means abundant, in Warwick. Upton-on-Severn, Arrow near Alcester, and Weston-on-Avon are mentioned as Worcester localities (Jenkinson, *Journ. cit.*, 1857, 5590, see also Tomes). North of the Wash, Caton Haigh's description (*Journ. cit.*, 1887, 144) of a "rather large dark-coloured Bat," frequently observed "flying low over grassland, so low as only just to clear the higher stalks of grass . . ." moving "heavily with slow flaps of its wings, and . . . generally seen in the neighbourhood of trees"—suggests this species as a regular member of the Lincoln fauna. A male in the British Museum, labelled Cheshire but without further data (cited as a female by Dobson, *Catalogue of Chiroptera*, 177), and two examples captured near Carlisle, are the only known specimens from the north of England. The latter are stated by Macpherson to have been skinned for T. C. Heysham; after his death they were purchased by Bond, in whose house Macpherson examined them in March 1886. Since August 1889 they have been in the possession of Harting, who writes me that the details given above are confirmed by Bond's own handwriting on the labels.

The species was not known from **Wales** until, on 13th June 1904, Rev. D. E. Owen sent two for identification to Forrest from Llanelwedd, near Builth, on the Brecknock border of Radnor: they proved to be members of a definite and well-established colony (Forrest, *Zoologist*, 1904, 262; *Trans. Caradoc and Severn Valley Field Club*, iv., 1, 52-54, 1905, Jan. 1906).

The interpretation of the records is a matter of some difficulty, but the fact that the bat is well-known, although not abundant, in Essex, Norfolk, and Warwick; that it has definite colonies in Somerset and Worcester; and has been taken at intervals within the area of every county south of the Wash and east of the Dee, suggests that further observation will show it to be widely distributed in small numbers, at least within the above limits, with outposts beyond them, as in mid-Wales. The record from Carlisle may point to a gradual extension of range or to wandering habits: Macpherson attributed it, although without definite grounds, to migration. There is nothing in the bat's European distribution to suggest any inherent improbability of its occurrence in the north of England or even in Scotland.

Distribution in time:—This bat is not known as a fossil.

The **breeding habits** are unknown.

Description:—The general form and appearance of this remarkable bat are typically those of its genus.

The **ear** (Fig. 2, No. 9, p. 7) when stretched forward reaches slightly

[1] A record recently confirmed by A. Whitaker, who examined two caught at Faversham on 17th May 1910 (*Naturalist*, 1910, 424).

beyond the tip of the muzzle[1]; it is nearly as broad as long and irregularly four-sided; the inner edge is reflected, forming a longitudinal groove just within the margin; the outer and superior angle is prominent, rounded, and turned back; immediately beneath this, on the external margin, is a rather deep notch, from which five or six slight transverse folds extend about half-way across the conch; the anterior inner angle unites with its fellow immediately behind the muzzle. The tragus has a length more than half that of the ear; it is of an irregular lanceolate or semicordate form, with one conspicuous and two or three smaller protuberances near the base of the superiorly concave outer margin; the terminal third is straight and the apex rounded; the inner margin is faintly convex.

In the **wing** (Plate XVII., Fig. 2) the most remarkable features are the small foot and large lower leg, the proportions of which are unique amongst British vespertilionid bats. The tail, longest digit, as well as the third and fifth metacarpals, are, as compared with their forearm, exceptionally long. The fifth metacarpal is distinctly shorter than the third. The result is a wing amply, but not exceptionally broad, and a large interfemoral membrane.

The **fur** is soft and long. The upper side of the muzzle is naked, but the tumid cheek is thickly clothed with hair, forming a kind of moustache and almost concealing the eye. The wing on the upper surface is furred thickly to about as far as a line passing from the knee to the centre of the humerus, and on the interfemoral membrane to a line running from slightly above the knee-joint to a point one-third of the distance along the tail. Beneath, the fur extends somewhat beyond a line joining elbow and knee, and a sprinkling of hairs runs along the membrane behind the forearm to the carpus. On the outer side of the ear a thick column of fur clothes the central and lower portions, but the outer margin is bare; the inner margin is fringed for almost its whole length by a band of hairs. On the inner surface the conch is sprinkled with hairs: a thick band of hair runs along the line of the anterior folding almost to the apex, becoming thinner as it ascends.

The **colour** above is dusky, almost black, most of the hairs having whitish or yellowish tips, thus causing a frosted appearance, which may be most conspicuous in the region between the shoulders. Beneath, the colours are similar, but the light tips are more numerous, whiter and longer, and their influence predominates increasingly towards the furred portion of the wings and interfemoral membrane, which are lightest, the dusky basal portions of the hairs being there absent. The wing, ear, foot, and nose are dusky.

[1] At least in fresh specimens. Dobson's statement that, "laid forwards the tips extend to a point midway between the eye and the end of the muzzle" (*Catalogue of Chiroptera*, 176), may have been based on stale specimens distorted in alcohol.

The nearly full-grown young are said to differ from the adults in having the underside darker.

The **skull** (Fig. 8, No. 5, p. 101) and **teeth** (Fig. 22) are typical of the genus.

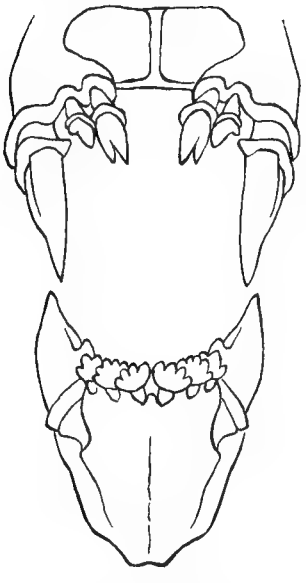


FIG. 22.—FRONT VIEW OF INCISORS AND CANINES OF *Barbastella barbastellus* (enlarged and diagrammatic).

No material exists on which to base a study of the **variation** of this species. Millais mentions a golden-brown form, and Tomes two immature examples, one of which was perfectly white; the other (now in the British Museum) had the body pure white, but the head, part of the neck, and lower dorsal region normal; in both, the wings were almost white. A third, taken at Alcester, Warwick, had the fur of the under parts, from root to tip, strongly tinged with purplish red or rose colour, which was very conspicuous when the animal was fresh, but faded considerably after preservation. There is much variation in the extent of the frosting of the hairs, some specimens being very dark; Lord Lilford mentions a dark brown male taken on 22nd March, and a very grey female taken on 4th September (*Zoologist*, 1894, 187 and 395).

As regards size, the forearm in eight British specimens measured by me averages 1·5 mm. less than in thirteen from the continent of Europe, but the difference is too minute and the series too small to afford basis for a definite conclusion.

Proportionate lengths:—Foot, without claws, about ·30 of lower leg; fifth metacarpal, about ·93 of third; lower leg, about ·49 of forearm, and about ·38 of head and body.

Skull:—Greatest length, 15; basal length in middle line, 10·6; palatal length in middle line, 5; from posterior border of m^3 to anterior border of canine, 5; greatest breadth at zygoma, 7·7; posterior breadth, 7·5; breadth between orbits, 5; breadth at constriction, 3·5.

The **weight** is given by Fleming as 100 grains = 6·5 grammes.

Distinguishing characters:—The Barbastelle cannot be mistaken for any other European bat. Apart from its dark colour, in no others—except the Long-eared, the immense ears of which are very different—are the internal margins of the ears joined together. The latter character is evident even in the unfledged young.



1



2



3

WINGS ($\frac{1}{2}$ natural size and diagrammatic) OF

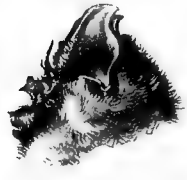
1. *Plecotus auritus.* 2. *Barbastella barbastellus.*
3. *Rhinolophus hipposideros.*



1



2



3



4

HEADS (natural size) OF

1, 2, and 3. *Rhinolophus hipposideros* (front, three-quarter, and side views).
4. *Rhinolophus ferrum-equinum.*

DIMENSIONS IN MILLIMETRES:—

	Head and body.	Ear, greatest length.	Tragus, greatest length.	Tail.	Lower leg.	Hind foot, without claws.	Forearm.	Thumb, without claw.	Longest digit.	Metacarpal III.	Metacarpal V.	Greatest expanse of wings.
Male, Arrow Lodge, Warwickshire, 7th October 1846 (R. F. Tomes's collection), measured from dried skin at British Museum .	..	..	..	42	18	..	37	4	65 approx.	34	32	..
Male, Oundle, Northants, 5th April 1900 (Lord Lilford), do. . . .	50*	..	..	48*	18	7	38	4	68	35	33	..
Male, Milton, Hants, 7th April 1900 (Rev. J. E. Kelsall), do. . . .	52*	16*	6*	44*	18·5	6·5	36	3·25	66	34	31·5	260
Male, Llanelwedd, Radnorshire, 6th June 1904 (H. E. Forrest), do.	..	..	..	43	19	6·5	38	4·5	68·5	35·5	33·5	254*
Male (received from E. A. Wilson), 5th Oct. 1906, measured in flesh	46	12·7	7·5	..	19·5	7·5	38	5	63·5	35·5	34	..
Male, Cheshire (G. E. Dobson), measured from spirit in British Museum . . .	45	14·5	6·5	40	19	6	39	5	67·5	35	31	..
Average of males (approximate) .	48	..	..	43·4	18·6	6·7	37·6	4·3	66·4	34·8	32·5	..
Female, Elton, Hunts, 4th Sept. 1894 (Lord Lilford), measured from dried skin . . .	60*	..	..	..	18	6·5	36	4	63·5	35	31	..
Female, Epping Forest (H. Doubleday), measured from alcohol .	44	16	8	43	19	6	37	4	65	32	30	..
Female, Herts, received in flesh from C. Oldham, 16th Sept. 1908 .	51	13·5	9	54	20	7	41	4	67	37	35	268

* Collector's measurements.

This curious and interesting bat was first described by Daubenton in 1760, and subsequently by Buffon in his great work. Kuhl, notwithstanding the extent of his researches and his exertions to procure all the bats of Germany, failed to obtain one of this species. It was first detected as a native of Great Britain by Peete, who sent one to Sowerby from the powder mills at Dartford in Kent. It was known to Montagu from Devonshire, and subsequently obtained a place in all works on British Mammals except that of Donovan.

Although quite unmistakable in the hand, many of the earlier published notices of the habits of the Barbastelle were clearly incorrect, and the meagre accounts available

made any attempt to write its natural history difficult until the Rev. D. E. Owen and Mr G. E. Bullen sent Mr H. E. Forrest an account of a colony in the porch of Llanelwedd Church, Radnorshire. All that could be said for certain was that, of the few recorded specimens which had been captured, the majority were discovered either in houses, or resting on or under the bark of trees.[1] Others owed their detection to their appearance on the wing in broad daylight,[2] a proclivity which Mr Eardley Hall, who, according to Mr J. G. Millais, has had good opportunities for observing this species, believes to be the rule and not the exception.

The first notice of its natural history came from the pen of Bell, who received from Dr Waring a specimen taken during a very hard frost in the latter end of December, in a large chalk-cavern excavated at the bottom of a shaft seventy feet deep, at Chiselhurst, in Kent. "In this cavern," wrote Bell, "during very severe frosts, several species of Bats are found to retreat; and on this occasion, with the Barbastelle was received a specimen of the" Whiskered, three of Natterer's, and several of the Long-eared Bat. "These little prisoners, when brought into a warm room, soon began to exhibit signs of vivacity; and the Barbastelle, with the others, fed readily on small bits of meat, and drank water. He was a timid animal, and did not evince the slightest disposition to become familiar; he would take his food, however, with his companions, and was accustomed to rest with them in a cluster, at the top of the box in which they were placed. The Barbastelle certainly became torpid more readily than any of the others, and more completely so; but when awake, evinced extreme restlessness, and was incessantly biting with great violence at the wires of his box. When suffered to fly about the room, he flew very low, and less actively than the others under similar circumstances; and he was fond of lying before the fire on the hearth rug, where he appeared quite to luxuriate in the warmth. Whilst the Long-eared Bats evinced much attachment to each other, and became very familiar with me, the Barbastelle

[1] See A. Newton, *Zoologist*, 1857, 5421; Lord Lilford, *ibid.*, 1894, 187.

[2] See H. P. Blackmore, *ibid.*, 1869, 1558; C. W. Brazenor, *ibid.*, 1887, 152; A. H. Cocks, Jenyns, etc.

remained sullen and apart; until at length I found that he was an object of persecution on the part of his more active companions, one of whom I detected in the act of giving him a severe bite on the back of the neck. This occasioned his immediate removal to another box; but this sharp discipline probably hastened his death, which took place about a week afterwards, though he continued to eat till the day before he died."

Nothing further of any importance was written on the Barbastelle until R. F. Tomes met with it in Warwickshire, and remarked[1]: that "if in a twilight stroll about midsummer a person finds himself in a close proximity with a Bat of somewhat thick and clumsy form, but of rather small size, whose flight is so desultory that it appears to be flapping lazily about, hither and thither, seemingly without purpose, and intruding so closely that the flutter of its wings may be heard, and even the cool air thrown by their movement felt upon the cheek, it may with almost certainty be recognised as the Barbastelle. Although there is no English Bat which resembles the Barbastelle in its mode of flight, yet in choice of situation there are several. Where the Whiskered Bat and Pipistrelle are seen, the Barbastelle may be seen also, but having been once observed, it will, probably, be useless to make search again at the same place. Equally uncertain is its diurnal retreat; most likely not the same place for long together, as we have found it in places where it could not have rested the day previously. A crevice in a wall or tree, the spaces between the rafters and tiles of a cowshed, the timber over a sawpit, the thatch of a shed in a brickyard, or behind a cottage window-shutter, are suitable places of repose for the Barbastelle, in all which situations we have met with it, and always alone."

In these few words Tomes seems to have hit off with considerable accuracy the "flapping," almost aimless flight of what would appear to be, at least occasionally, a wandering species, living a life exempt from the routine which seems to be so marked a feature in the daily existence of some others. His estimate of its solitary habits not only when in its place

[1] In Bell.

of repose during the day, but during its evening flight, proves to have been less correct, although supported by Dr Henry Laver; for, besides the evidence of the Radnorshire colony, we have Mr Millais's statement, on the authority of Mr A. G. Berry, that a small flock frequents the roof of Wells Cathedral. Again, Mr J. H. Jenkinson[1] met with a party of six or seven in their hiding-place in the month of June; and in the spring on another occasion discovered a mixed assemblage, consisting of a Natterer's Bat, a Barbastelle, and two or three Pipistrelles. True, he does not say definitely that the bats were in the latter case actually together, although undoubtedly inhabiting adjacent crevices, but Lord Lilford expressly states[2] that he "found this curious-looking little animal in great abundance in a ruined monastery in Arragon, at the foot of the Pyrenees, . . . and in smaller numbers in a similar locality at Pótes, in the province of Santander," so that there must be seasons, perhaps those of procreation, when it courts the society of its own species.

It thus appears that the Barbastelle is no less sociable[3] and gregarious, perhaps even more so, than the Long-eared and other species. Some of those which Mr Owen found hanging from a beam in the church porch at Llanelwedd, had formed themselves into a small and compact ball. A week later a bunch of ten were found occupying the same position, so that it is evident that at least in summer this species has rightly gained its reputation for wandering. When disturbed early in the morning or in the afternoon, the Barbastelles were in a condition of deep torpidity, markedly distinct from the state of the Long-eared Bat, but their actions were very different at eventime, when if disturbed they exhibited great agility in attempting to avoid capture.

In Radnorshire the Barbastelle is an early-flier, leaving its diurnal resting-place at sunset, and preceding by some little time the Pipistrelle, the Long-eared Bat, and even the Noctule. Mr Owen has often seen the swifts and Barbastelles flying about his rectory for nearly an hour before the former retired for the night. Their habits and flight vary with the weather.

[1] *Zoologist*, 1857, 5590. [2] *Ibid.*, 1887, 66-67.

[3] Two Cambridgeshire specimens were found hanging side by side on the wall of an old shed much frequented by Long-eared Bats. They were "almost, but not quite, touching one another" (Arthur Whitaker, *Naturalist*, 1910, 424).

When it is fine, they fly high and do not enter the church, probably sheltering themselves amongst the branches of the yew-trees, but rain or wind drives them to seek the shelter of the porch or tower, and to fly round the building with a slower and more ponderous flight.

Mr Forrest is inclined to believe that this bat is silent while on the wing: at all events he has never heard it cry in flight. When captured, however, "some of them made the usual metallic squeaking noise, whilst one or two of them made a noise very much like that of a huge bee held in a handkerchief." They repeated these two distinct cries when recaptured after having been released in a room.

In captivity their demeanour varied, one readily consenting to eat chopped steak, another refusing food, but none lived for more than a few days. Mr Forrest remarks that they flew against the window, but not with the blind dash of an imprisoned bird. When walking or crawling they "straddled" their limbs more than other bats, and their movements were slower. He noticed that the head was habitually held downwards, so that it was difficult to obtain a view of the curiously wizened face.

More recently Mr Charles Oldham[1] has kept a bat of this species alive in captivity for a few days, and remarks that it had two notes, a querulous squeal of the usual bat-like kind and a peculiar subdued buzzing. In a room its flight was slow and fluttering, and it generally preferred the upper part of the room, but occasionally flew close to the ground amongst the legs of chairs and tables. In flight its tail was extended and only slightly decurved; the legs were held wide apart, so that the interfemoral membrane looked very large from beneath. As a rule, but not always, it turned in the air like a Natterer's or Horseshoe Bat, before alighting. After some preliminary difficulties it was induced to accept mealworms, but seemed to fear cockroaches. It preferred to eat on the wing, but was not observed to call in the assistance of the interfemoral pouch, the nature of its food probably making such a course unnecessary. It was adroit in picking houseflies off the ceiling.

Four facts are thus demonstrated for the first time:

[1] *Zoologist*, 1908, 391-392.

that this bat is distinctly gregarious; that its flight begins very early in the evening; that it is exceptionally active in alighting and passing obstacles; and that it knows how to catch its prey while at rest. The latter fact was indeed to be expected from its peculiar facial attachments, but it must be remembered that the behaviour of this, as of any other species, may vary so much with the occasion, the individual, or the season, that no hard or fast rule can or should be drawn from the result of merely one or two observations.

According to Messrs R. Rollinat and E. L. Trouessart, the Barbastelle is in France a hardy species, and that is what might be expected of one whose range includes portions of Skandinavia. Its hibernatory slumber is probably not deep, and it has been captured abroad on a fine New Year's Day.[1] For the rest I can only find notes that it has been observed in activity on various dates from 3rd March[2] to 3rd October.

The breeding habits are unknown, but the late Thomas Southwell showed me a letter from S. Bligh to Henry Stevenson, wherein the newly born young, picked up at Framlingham, Suffolk, in 1865, are said to have been easily recognised by their ears, a character which at all ages is infallible for the distinction of this species.

[THE HOARY BAT.

NYCTERIS CINEREUS (Beauvois).[3]

The record[4] by John Wolley, of the occurrence in South Ronaldshay, Orkney, about September 1847, of a specimen of the Hoary Bat of North America, has long been relegated to obscure corners of British faunal works on the ground that, as indeed Wolley himself supposed, the animal must have been conveyed across the Atlantic accidentally in a ship. The bat was caught by some potato-diggers, and is stated to have been kept alive for some weeks.

[1] See H. P. Blackmore, *Zoologist*, 1869, 1558.

[2] R. Mitford, *ibid.*, 1860, 6953; Lilford, *ibid.*, 1894, 395; Owen, per Forrest.

[3] For use of *Nycteris* (replacing *Lasiurus*), see Miller, *Proc. Biol. Soc.*, Washington, 17th April 1909, 90.

[4] Under the name *Vespertilio pruinosus*. See *Zoologist*, 1849, 2343; 1850, 2695-96, 2813-14, for an accurate description, excepting only that the number of the teeth is given incorrectly.

different from that of a bird. Even where the latter are concerned, the proportion of American visitors detected may be infinitesimal as compared with those which escape recognition; but the chances that a bat should be discovered, or even that it should survive its passage, are remote.

Unfortunately, a new complication has arisen, and the matter is not as clear as it might be. Wolley's original specimen is said to be preserved in the University Museum of Zoology at Cambridge, and I am indebted to the late Professor Alfred Newton for bringing the fact under my notice. There is evidently, however, something wrong, since the specimen which now does duty for Wolley's belongs to a species[1] having its habitat in the Sandwich Islands, and does not agree with Wolley's very clear description. After so many years it is impossible to explain the mystery. The Cambridge specimen was dried and not skinned, and its condition would therefore suit the hypothesis that it was taken in the Orkneys. But if so, it is an entirely unlikely species to have arrived there alive, and doubtless never did so on its own wings. On the other hand, it is known, as the Professor informed me, that Wolley's brother, George, returned from the Sandwich Islands in 1856, so that it is possible that he brought this specimen with him, and that it was accidentally substituted for the bat taken at South Ronaldshay. This does not look an improbable solution, for John Wolley only wrote the label in 1858, and, being evidently doubtful of his information, he was careful to mark it with a note of interrogation. But if so, it is difficult to understand why George Wolley should have brought home an unskinned bat all the way from the Sandwich Islands, and it is to be feared that the matter cannot now be decided with certainty.

Two other American bats, both easily recognisable species, perform extensive migrations, and are at least as likely to be blown over to this country as the present species, viz., the Red Bat,[2] and the Silver-haired Bat,[3] but of these the latter, at least, is stated to have powers of flight inferior to those of the Hoary Bat.]

[1] *Nycteris semota* (Allen). [2] *N. borealis* (Müller).
[3] *Lasionycteris noctivagans* (Le Conte).

RHINOLOPHIDÆ.

HORSESHOE-NOSED BATS.

Characters:—These bats have a conspicuous nose-leaf; no tragus; a short tail and moderately developed interfemoral membrane; premaxillæ rudimentary, suspended from the nasal cartilages and only partially bridging the gap between the two upper incisors, which are quite rudimentary and widely separated; nasal bones much expanded.

GENUS RHINOLOPHUS.

1798. LES RHINOLOPHES, Georges Cuvier, *Tableau élémentaire de l'Histoire Naturelle des Animaux*, 105.

1799. RHINOLOPHUS, Le C. Lacepède, *Tableaux . . . des Mammifères*, etc., 15, No. 73; based on *Rhinolophus ferrum-equinum*.

1816. PHYLLORHINA, W. E. Leach, *Systematic Catalogue of the Specimens of The Indigenous Mammalia and Birds that are Preserved in The British Museum*, etc. (London), 1; based, without description, on *Phyllorhina minuta* of Leach = *Vespertilio minutus* of Montagu, the Small Leaf-nose, from Torquay, Devon, presented by G. Montagu; see Blanford, *Proc. Zool. Soc.* (London), 6th Dec. 1887, 637-638.

1836. RHINOCREPIS, F. L. P. Gervais, *Dictionnaire Pittoresque d'Histoire Naturelle*, iv., 2, 617, quoting from Cuvier and Geoffroy, *Magazine Encyclopédique*, vi., 1795, but the name does not occur in the paper referred to, nor, so far as is known, prior to 1799.

1847. AQUIAS, J. E. Gray, *Proc. Zool. Soc.* (London), 9th March, 15-16; *Ann. and Mag. Nat. Hist.*, June 1847, 408; based on *Rhinolophus luctus* of Temminck, and *R. trifoliatus* of Temminck.

1866. PHYLLOTIS, J. E. Gray, *Proc. Zool. Soc.* (London), 13th Feb., 81; based on *Phyllotis philippensis* of Waterhouse, i.e., *Rhinolophus philippinensis*; preoccupied by PHYLLOTIS of Waterhouse, 1837, a genus of *Muridæ*.

1866. SPEORIFERRA, J. E. Gray, *Proc. Zool. Soc.* (London), 13th Feb., 82; based on *Speoriferra vulgaris*, i.e., *Rhinolophus vulgaris* of Horsfield.

1866. CŒLOPHYLLUS, W. Peters, *Proc. Zool. Soc.* (London), 22nd Nov., 427; based on *Rhinolophus cœlophyllus* of Peters.

1887. PSEUDORHINOLOPHUS, Max Schlosser, *Beiträge zur Paläontologie Österreich-*

Ungarns, etc., VI., i. and ii., 55, 61, pl. ii., fig. 42 ; based on *Rhinolophus antiquus* of Filhol and other extinct species.

1901. EURYALE, Paul Matschie, *Sitzungs-Berichte der Gesellschaft naturforschender Freunde zu Berlin*, 225 ; based on *E. méhelyi* of Matschie.

The genus is the only one of its family. There are two British species, *R. ferrum-equinum* and *R. hipposideros*. Outside Britain *R. euryale* of Blasius, occurring throughout the Mediterranean Region to central France, has the lip with three grooves, the sella with its sides parallel anteriorly and the posterior connecting process projecting and triangular; it has many sub-forms, such as *R. méhelyi* of Matschie and the Spanish *R. carpetanus* of Cabrera. Peters's *R. blasii* of south-eastern Europe has peculiar nose-leaf and lower incisors.

Distribution:—The seventy-one species and numerous sub-species recognised by Andersen (*Ann. and Mag. Nat. Hist.*, Dec. 1905, 648-662 ; *Proc. Zool. Soc.* (London), 17th October 1905, 75-145), range from Ireland through southern Europe and Asia to Ceylon and Malaysia, the Celebes, Philippines, Formosa, Japan, the Liu-kius, and Australia. They nowhere attain to high altitudes, and are probably not found farther north than the shores of the Baltic (*R. hipposideros*) or southern Korea (*R. ferrum-equinum nippon* and *R. cornutus*). Andersen refers existing species to six "types," all of which he believes to have had their origin in the Oriental Region.



FIG. 23.—DIAGRAM OF NOSE-LEAF OF *Rhinolophus*.

a, sella. *b*, lancet. *c*, *c*, eyes. *d*, division between the nostrils. *e*, *e*, horseshoe.

The genus is **characterised** by moderate or small size, highly developed nose-leaf with triangular posterior portion, and deeply notched ear with well-developed antitragus.

The **nose-leaf** consists of three distinct sections, of which the anterior, shaped like a horseshoe, rests flatly on the muzzle, and encloses the nostrils

within its arms. The median section or sella commences behind or between the nostrils, and from a recumbent anterior portion rises posteriorly into an erect, horn-like, connecting process, standing vertically upon the face. From the sella there runs backwards a process connecting it with the posterior section or lancet, which is tongue-shaped and terminates posteriorly in a single point.

The **wing,** which arises from the ankle, is very large and broad, the fifth metacarpal being longer than the third: the area between digits two and three is large, and the base of the thumb is included in the antebrachial membrane. The second digit has one joint only, the metacarpal; the third three, the metacarpal and two phalanges. The first toe has two joints, the remainder three each.

In addition to the single pair of pectoral **mammæ** the females are provided with two nipple-shaped prominences in front of the pubis, to which the young attach themselves by their teeth. These false nipples produce no secretion, and are not in communication with any gland: they are attached by fibrous tissue to the pubis (see Rollinat and Trouessart, *Mém. Soc. Zool. de France*, x., 1897, 124).

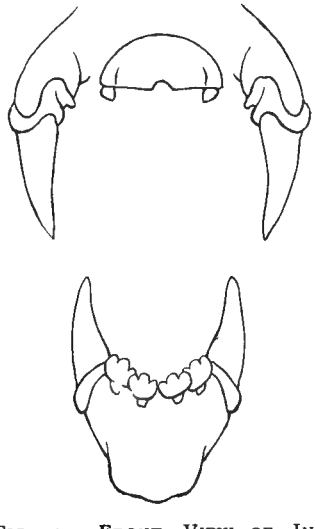


FIG. 24.—FRONT VIEW OF INCISORS AND CANINES OF *Rhinolophus* (enlarged and diagrammatic).

The **teeth** (Figs. 25 and 26) are thirty-two, arranged as—

$$i\frac{1-1}{2-2},\quad c\frac{1-1}{1-1},\quad pm\frac{2-2}{3-3},\quad m\frac{3-3}{3-3}=32.$$

The lower incisors are tricuspid. The upper incisors, although minute, are always present in the always ossified premaxillæ. The anterior upper premolar is minute, and often crowded out of the tooth-line externally by the large canine and posterior premolar. The central lower premolar is often in similar position between the neighbouring teeth. The molars are well-developed and their cusps acutely W-shaped. The milk teeth undergo absorption in the embryo.

THE GREATER HORSESHOE BAT.

RHINOLOPHUS FERRUM-EQUINUM (Schreber).
RHINOLOPHUS FERRUM-EQUINUM INSULANUS (Barrett-Hamilton).

1760. LE FER-À-CHEVAL, L. J. M. Daubenton in E. L. le Clerc, Comte de Buffon's *Histoire Naturelle*, viii., 131-133, 135, 137, pl. xx., figs. 1 and 2; also, *Mém. de l'Acad. Roy. des Sci.*, 377, 382, pl. 15, fig. 4, 1759, published 1765; described from France.

1774. VESPERTILIO FERRUM-EQUINUM (in part), J. C. D. von. Schreber, *Die Säugthiere*, i., pl. lxii., upper of two figs, 174, 190; evidently naming Daubenton's *Le Fer-à-cheval;* Montagu, *Transactions Linnean Soc.* (London), ix., 162, 1808; Bingley; Donovan; Clermont.

1776. VESPERTILIO EQUINUS (in part), P. L. S. Müller, *Natursystems Supplements und Register Band*, 20, renaming Schreber's *Vespertilio ferrum-equinum.*

1779. VESPERTILIO PERSPICILLATUS, J. F. Blumenbachs, *Handbuch der Naturgeschichte*, 75 (part); included the leaf-nosed bats of Europe and South America.

1785. VESPERTILIO UNGULA (in part), P. Boddaert, *Elenchus Animalium*, i., 71, renaming Schreber's *V. ferrum-equinum.*

1788. VESPERTILIO FERRUM-EQUINUM, a major, J. F. Gmelin, *Systema Naturae*, i., 50.

1792. VESPERTILIO FERRUM EQUINUM MAJOR, Robert Kerr, *Animal Kingdom*, 99 (not *V. molossus major* of Kerr, *op. cit.*, 97); described from France.

1797. NOCTILIO FERRUM-EQUINUM, J. M. Bechstein, *Der Zoologe*, 1, i.-viii., 62.

1798. VESPERTILIO HIPPOCREPIS (in part), F. von P. Schrank, *Fauna Boica*, i., 64.

1803. RHINOLOPHUS MAJOR, Étienne Geoffroy, *Catalogue Mammifères Mus. d'Hist. Nat.* (Paris), 56; described from Burgundy.

1807. VESPERTILIO FERRUM EQUINUM MAJUS, Lazare Spallanzani, *Rapports de l'air avec les êtres organisés*, etc., edited by Jean Senebier, ii., 77 (Geneva); described from Nonantola, near Modena, or from Scandiano, Italy.

1813. RHINOLOPHUS UNI-HASTATUS, Isidore Geoffroy, *Ann. du Mus. d'Hist. Nat.*, xx., 257; described from Europe.

1817. RHINOLOPHUS FERRUM-EQUINUM, W. E. Leach, *Zoological Miscellany*, iii., 2; Harting, *Zoologist*, 1887, 2, pl. i. (G. E. Lodge), *et plurimorum auctorum.*

1829. RHINOLOPHUS UNIFER, Jakop Kaup, *System der Europäische n. Thierwelt*, i., 104; without description, hence a *nomen nudum.*

1862-63. RHINOLOPHUS FERRUM-EQUINUM, var. GERMANICUS et var. ITALICUS, Carl Koch, *Jahrbücher des Vereins für Naturkunde im Herzogthum* (Nassau), xviii., 522-523; described from Europe, north and south of the Alps respectively, but evidently in error (see Andersen, *Proc. Zool. Soc.* (London), 16th May 1905, 113 footnote).

1872. RHINOLOPHUS LIBANOTICUS, CONCHIFER, *et* RUFESCENS, "*Ehrbg. et Lichst. Mpts,*" W. Peters, *Monatsberichte der Königlich Preussischen Acad. der Wissenschaften* (Berlin), 1871, 310; without description, hence a *nomen nudum.*

1885. RHINOLOPHUS UNIHASTATUS var. HOMORODALMASIENSIS, Daday Jeno, *Orvos—Természettudományi Értesitö*, etc., x. (3), 274; described from Homoród—Almas, Hungary, in error (see Méhely, *Monographia Chiropterorum Hungariae*, 120-122 and 323, 1900).

1887. RHINOLOPHUS FERRUM EQUINUM, var. HOMORODENSIS, Daday Jeno, *Értekezések A Természettudományok Köréböl*, Budapest, xvi., No. 7, 13, pl., figs. 5 and 6, 1886; renaming his var. HOMORODALMASIENSIS.

1905. RHINOLOPHUS FERRUM-EQUINUM TYPICUS, Knud Andersen, *Proc. Zool. Soc.* (London), 17th October 1905, 113.

1910. RHINOLOPHUS FERRUM-EQUINUM INSULANUS, G. E. H. Barrett-Hamilton, *Ann. and Mag. Nat. Hist.*, March, 292; described from Cheddar, Somersetshire, England (type in British Museum); Trouessart, 1910.

Le Fer-à-cheval of the French; *die grosse Hufeisennase* of the Germans.

Synonymy:—The synonymy of our two British Horseshoe Bats was very much confused until the end of the eighteenth century, when they were first separated by J. F. Gmelin, and later by Bechstein. Kuhl thought them one species, and although Daubenton was well aware of the distinctions between them, there is nothing in his descriptions to indicate that he had formed any more distinct opinion. (See also under *R. hipposideros*.)

Distribution:—*R. ferrum-equinum* ranges from sea-level to 7000 feet in the Himalayas; from the south of England through central Europe, the Mediterranean region—exclusive of Egypt—and the Himalayas to south China and Japan. Its habitat includes at least the islands Cyprus, Sicily, and Minorca. It is, with *P. pipistrellus*, the commonest bat of Normandy (de Kerville, *Naturaliste*, 15th October 1891, 239); and in the west, south-west, and centre of France it is also abundant, but less so in the east (Rollinat and Trouessart, *Mém. Soc. Zool. de France*, x., 1897, 114). It is common in Guernsey (Bunting).

In Britain it is confined to the south, mainly the south-west of **England** and the south and west of **Wales**, and is not known from **Scotland** or **Ireland** (see below). It was discovered by Latham, who found it in the powder mills of Dartford,[1] Kent (Pennant, *British Zoology*, ed. iv., 129, pl. xiv., 1776), and later was encountered by Montagu in considerable numbers in company with *R. hipposideros*, in Kent's Hole, the well-known cavern near Torquay, Devon. More recent records have connected it with Hampshire, the Isle of Wight, Gloucester, Somerset, and Cornwall, in some parts of which counties it occurs abundantly. So far as is known, it has never been reported from Sussex (neglecting the indefinite record of one discovered on the sail of a fishing-boat on Brighton beach, see Ruskin Butterfield); and it is quite unknown to Laver in Essex (Bell's statement, repeated in Cassell's *Natural History*, i., 283, and by Millais, that it occurs at Colchester, being evidently an error, based, as Laver informs me, on a statement made by the botanist Curtis to Yarrell). Kelsall (*Zoologist*, 1884, 483) states that one was shot on the Berkshire side of the river at Oxford (lat. 51°, 46′) about 1875; 15 miles further south Noble took two in his cavern in the same county, near Henley-on-Thames, on 14th March 1909 (see Cocks, *Journ. cit.*, 1909, 154); the first-mentioned

[1] Not, as stated erroneously, at Dartmouth, Devon (see Rowe).

Berkshire locality is almost the most northerly recorded for England, but must just give place to Whitchurch (lat. 51°, 51′), near Ross, on the Gloucester border of Hereford, whence, as Forrest informs me, Rosse Butterfield received six from a cave in November 1910. At almost the same latitude as Henley, De Winton observed it (*vide* Millais) in the Zoological Society's Gardens, Regent's Park, London. Next come two Gloucester localities, viz., Westbury-on-Trym and the Cathedral at Bristol (Rudge King and Charbonnier). Amongst the other localities from which it has been taken or recorded within its range are:—In Somerset, Clifton (Eagle Clarke), Hampton Road, near Bath, Wells Cathedral, and Clevedon (Charbonnier), the Mendip Caves (particularly abundant, *fide* Laver; also Lewis, *Zoologist*, 1906, 69) and Taunton (Millais); in Wiltshire, Great Cheverell (*Journ. cit.*, 1910, 307); in Surrey, Godstone (rare, Bucknill and Murray); in Kent, Rochester Cathedral and Margate (Bell), Maidstone and Dover (Millais), and Canterbury (abundant, Borrer, *Journ. cit.*, 1874, 4129); in Hampshire, Portsmouth (Borrer, *loc. cit.*), and Christchurch (Trevor-Battye and Lascelles); in Wight, Sandown, Farringford, Bonchurch, and the Undercliff (the commonest large bat of the latter, see More, Bury, Millais, Wadham); in Dorset, Tomson Manor (Salter, *Zoologist*, 1865, 9835); in Devon, Teignmouth (Jordan, *Journ. cit.*, 1843, 75), Torquay (De Hügel, *Journ. cit.*, 1869, 1768), Hooe, Plymouth, and Plympton (Rowe); in Cornwall, several localities (see Clark); a Yorkshire record in the *Journ. cit.*, 1884, 483, Editor's note, is an error (see Roebuck, *Journ. cit.*, 1885, 24).

In **Wales** the bat has a haunt at the Mumbles, near Swansea, Glamorgan (*Field*, 1st Jan. 1881, 24), and has been found by Tracy in the old Wogan Cavern, near Pembroke Castle, Pembroke (Kelsall, *Zoologist*, 1887, 89); Grabham also took a specimen from a disused mine near Penmaenpool, Merioneth (Caton Haigh, *Zoologist*, 1896, 433); and Forrest received another, shot by Rawlings on 5th February 1896, at Barmouth, in the same county (both in lat. 52° 30′).

M'Coy suggested that a bat of "great size" captured in Co. Westmeath, **Ireland**, prior to 1845, and characterised by the possession of "a large-pointed appendage on its nose," was of this species, but the evidence of its identity was entirely hearsay, and it may well have been an example of some exotic form. M'Coy appears to have mentioned the occurrence in a paper read before the Dublin Natural History Society, on 12th Feb. 1845, reported in *Saunders's News-letter* of the same date, and quoted by J. R. Kinahan before the same Society on 1st April 1859 (see Dublin *Nat. Hist. Review*, vi., 383, 1859).

The almost entirely south-western distribution of *R. ferrum-equinum* (south of 52°) in England, together with its extension northwards on the Welsh coast to a point nearly a degree north of its English range,

is one of the most striking facts in the distribution of British mammals.

Distribution in time:—Bones of this bat from Kent's Hole, near Torquay, appear to be of very different ages, some resembling in condition those of mammoth, hyæna, and rhinoceros found with them, while others are quite recent (see Owen, *British Fossil Mammals*, etc., 15-16).

Breeding season, and **number of young**:—Very little information on these points has been published by British naturalists. In Germany the young are stated to be two, sometimes only one (Kuhl), but Rollinat and Trouessart, whose interesting observations (*Comptes rendus Soc. Biol.* (Paris), 26th January 1895, 53-54, and 6th July 1895, 534-536; also *Mém. Soc. Zool. de France*, x., 1897, 114-134) have been strangely overlooked, find that in France the latter number is never exceeded.

As in the *Vespertilionidæ*, copulation takes place in the autumn (but see under *R. hipposideros*), the earliest date at which spermatozoa have been found in the uterus of a female being 5th October. After copulation the spermatozoa become imbedded in a "bouchon" or body formed of mucus hardened after secretion within the vagina. In October the females are extremely fat, the mammary glands show no trace of milk, the ovaries are small and pale rose-coloured, the uterus normal with the exception of a slight enlargement of the right horn, but the vagina full of a thick white substance, rich in spermatozoa. By November this has hardened to form the "bouchon."

Ovulation and fertilisation take place in March, or more often, early in April (Duval, *Journ. de l'Anat. et de la Physiol.*, xxxi., March-April 1895, 93-160), the exact date depending on the conclusion of the hibernatory sleep. A female kept alive by Coward for nine weeks was found to contain a small embryo on 28th February, but hibernation had been interrupted during the whole period of captivity.

The fertilised ovum invariably takes up its position in the right horn of the uterus. Subsequently the "bouchon," now of no further use, is expelled from the vagina, tearing the vulva in its passage.

By the end of April the right horn of the uterus containing the embryo is as large as a pea or a very small hazel nut, and the first young one was observed clinging to its mother on the 20th June. The **period of gestation** is, therefore, ten to twelve weeks. By 3rd July most of the young are born, but late births take place up to about the 20th; the mothers have the pectoral mammary glands fully developed, but the nipples are shorter than the false ones of the pubis: the uterus is in atrophy, but the right horn still forms a large pocket.

Young of the first year, of both sexes, although associating with the breeding females, prove on dissection to be not sufficiently developed to breed; the young females pair in their second autumn; the internal

organs are very similar to those of the older females, but the right horn of the uterus, although slightly longer, is no larger than the left, and the false nipples are much smaller. One of these second-year females had not yet paired on 27th October. The "bouchon" is never formed in the females of the first year, and comparatively late in those of the second year.

Contrary to the views of Carl Vogt (*Association française pour l'avancement des Sciences*, x.; *Compte rendu*, 655, Algiers, 1881), Rollinat and Trouessart find no evidence that the young females pair in the spring of their second year; they are sure that they do not do so until their second autumn; some, perhaps, not till the third.

The males undergo a season of rut, their organs being well developed from September to May. The urethral gland, a structure peculiar to these bats and of doubtful function, is then of enormous size, although in the non-breeding season inconspicuous. Since the organs remain functional not only during autumn—the pairing season—but also throughout the winter and a part of the spring, it seems natural to suppose that copulation takes place during the latter periods. This suggestion, advanced by Robin (*Bull. de la Soc. Phil. de Paris* (7), v., 26th March 1881, 88), and at first supported by Rollinat and Trouessart, was later rejected by them on the ground of the existence of so great a number of virgin females just under a year old in April and May. The enormous reserve of apparently wasted spermatozoa is in this case a puzzling factor, but the authors suggest that it may be reabsorbed and utilised in accordance with the Brown-Séquard theory as an internal secretion. The presence of the "bouchon" in fertilised females must prevent subsequent copulation in winter and spring.

Young males, although possessing spermatozoa in their second autumn, probably do not breed until their third, when they are a little over two years old.

In the urethra of many males there occurs a sort of soft "bouchon," the function and origin of which is uncertain. It is possible that in bats, as in some rodents,[1] the secretion of the prostate gland has power to coagulate the mucous secretion of the vagina, and the beginning of coagulation may take place in the urethra of the male.

Description:—The general appearance of this bat is typical of its genus. In size it about equals the Noctule or Serotine.

The **head** (Plate XVIII., Fig. 4) is long, the occiput large and rounded, the muzzle very tumid and furnished with long, stiff hairs. The mouth opens straight and wide. The lower lip has a single groove and occasionally traces of two others, one on either side.

The **ear** (Fig. 2, No. 10, p. 7) is rather large, broad at the base, and

[1] L. Camus and E. Gley, *Comptes rendus Soc. Biol.* (Paris), 18th July 1896, 787.

when laid forward reaches well beyond the nostril; the apex is abruptly and distinctly pointed, and folded a little outwards; the outer margin, which is concave just below the tip, then slightly convex, is notched at its base and produced along the side of the face towards the corner of the mouth, forming in front of the auditory opening a rounded lobe which appears to be capable of closing the ear; from the outer margin extend ten or twelve sulci, which run tranversely to the middle of the ear and are crossed at right angles by a conspicuous blood-vessel; the inner margin is convex throughout, the lower two-thirds folded inwards so as to form a kind of flap.

In the **nose-leaf** the horseshoe is broad, parallel to the muzzle, but not nearly covering it, emarginate in front, and formed of three concentric elevations, of which the thickened inner one forms the walls of a depression in which are situated the nostrils. The sella, which is small and fiddle-shaped, commences anteriorly as a prominent process, its exposed surface being broadest anteriorly, and presenting a deep cup, divided equally by a low vertical septum; about its middle this process is somewhat contracted laterally, but posteriorly it again expands to nearly its former breadth and terminates in a short but conspicuous horn-like structure—the connecting process—rather acutely pointed at either end of its greatest length, which lies parallel to that of the body. At its base this horn is connected with the tongue-like lancet. This latter is distinctly longer than broad, and, from a breadth anteriorly almost equal to that of the horseshoe, tapers up the forehead to a point. Anteriorly a mesial ridge and two series of transverse and more or less horizontal septa divide the lancet into six irregularly paired cells, the posterior pair being much the least prominent.

The thumbs and feet are moderately stout, the latter armed with strong claws.

The **wing** (Plate IX., Fig. 3) arises from a point slightly above the ankle; the small interfemoral membrane projects slightly in the middle posteriorly; the tip of the tail is free. The antebrachial membrane is ample.

The second phalanx of the third digit is very long, and at least equals one and a half times the length of its metacarpal, which is considerably reduced in length, and the same proportion also holds good in the fourth digit. The fifth is slightly but decidedly the longest of the three. The proportions of the three are represented by the following figures:—

Forearm.	Metacarpal III.	Metacarpal IV.	Metacarpal V.
1000	644	724	743

The false nipples are very long, transversely wrinkled, and flattened; their colour is yellowish or brownish.

The **fur** is thick and soft, and in its texture suggestive of wool rather than fur; it thickly clothes the whole face except the nose-leaf; fur, ears, and nose-leaf uniting to almost bury the eyes. On the hinder surface of the ear the fur ceases at a point about one-third from the base, but a few small hairs are sprinkled on the outer margin, and on the inner a more conspicuous band reaches nearly to the apex. The reflected portion of the anterior margin is somewhat thickly covered with hair, which becomes thinner on the interior surface. On the upper surface of the wing the fur extends approximately to a line drawn from a point about one-third of the distance from the head of the humerus to the middle of the femur; a band of hair sometimes runs along the antebrachial membrane nearly to the elbow. The fur does not extend directly on to the interfemoral membrane, which however is sparsely furred to some extent on either side of the tail. On the under surface of the wing the distribution of the fur is somewhat similar, but there is no antebrachial band, a sprinkling extends from the body almost to the elbow and knee, and the interfemoral membrane is much more sparsely haired.

The nose-leaf is well supplied with bristles; in front there runs also a prominent single fringe, and a double row along the upper lip.

The **colour** in adults is uniform above, some shade between "mars brown" and "Prout's brown," the bases of the hairs "ecru drab"; the underside is "wood brown" washed with "ecru drab" on the throat and neck; there is no distinct line of demarcation. The wing, ear, and foot are deep brown; the false nipples light yellowish or brownish.

Immature specimens are conspicuously greyer, the general colour of the upper side (due to the hair-tips) being "drab" washed with brown from the shoulders backwards, where the dark tips are longer and almost conceal the whitish "ecru drab" bases. Beneath, the throat and neck are "ecru drab," the belly very light greyish drab. The young females of the first year, although almost as large as the adults, may also be distinguished by the absence of the false nipples, which do not appear until the second autumn, and even then are not of the full size (Rollinat and Trouessart).

The juvenile pelage persists at least until early February (Coward), when the epiphyses of the metacarpals have undergone ossification, although the teeth are still unworn. Exactly how and when the change to the mature pelage is affected is unknown.

In the **young** at birth the eyes are closed and the underside is naked and purple. There is a covering of short ash-coloured hairs on the upper surface, which grow rapidly and assume a dusky colour. The membranes are clear grey; the ears turned backwards; the nose-leaf as in the adult. The eyes do not open until after ten days (Rollinat and Trouessart).

In the **skull** (Fig. 25, No. 1) the palatal bridge is long, very nearly a third of the length of the maxillar tooth-row, a little more or less, but never so short as a quarter. The auditory bullæ are small, and the basi-occipital is not specially narrowed between them.

The anterior upper and central lower premolars are either wanting or minute, and, if present, are squeezed out of the tooth-row externally. The upper canine and posterior premolar overlap, the latter being external. The central and posterior lower premolars are in contact.

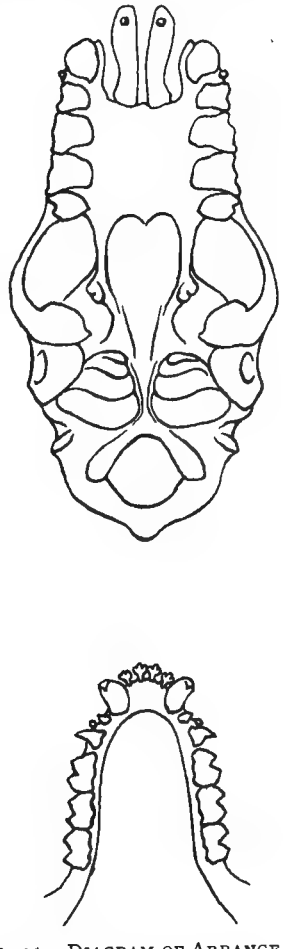


FIG. 25.—DIAGRAM OF ARRANGEMENT OF TEETH IN *Rhinolophus ferrum-equinum*.

(1) Upper and (2) Lower Jaw.

Variation:—Andersen finds a tendency to three grooves on the lower lip, and in the lancet to hastate, sometimes almost to cuneate, shape.

Geographical variation manifests itself in size, especially in that of the forearm, the teeth and nose-leaf, and in the length of the tail. Andersen (see above, p. 226) recognises six sub-species, three eastern and three western. The former are Temminck's *nippon* of Japan and south China, in which the size is moderate, the horseshoe broad, and the teeth rather small; Hodgson's *tragatus*, of the Himalayas, with large size and broad horseshoe; and Andersen's *regulus* of the north-western Himalayas, with narrow horseshoe and highly developed dentition. In all these the size is comparatively large, the tail short, and the two extra mental grooves often present. The three western sub-species are comparatively small, with longer tails, narrower skulls, and as a rule only one mental groove. Andersen's *proximus* of Gilgit is short-tailed as compared with the typical form. The latter ranges through southern and central Europe, exclusive of the Iberian Peninsula, to Transcaspia and the Euphrates Valley, and has the forearm usually 57 mm. and upwards. Cabrera's *obscurus*, of the Iberian Peninsula, the Balearic Islands, and Algeria, is said to differ only in having the forearm rarely exceeding 57 mm.; since there are doubts as to the validity of that variety, it is necessary to distinguish the British form, which has

undoubtedly a shorter forearm than the type, although with a skull of about equal size. It may be known as *R. ferrum-equinum insulanus* (*Ann. Mag. Nat. Hist.*, March, 1910, 292). Its forearm is even shorter than that of *obscurus*, with which form it cannot be phylogenetically identical, even if apparently indistinguishable.

DIMENSIONS IN MILLIMETRES:—

	Head and body.	Ear, greatest length.	Nose-leaf, greatest length and greatest breadth.	Tail.	Lower leg.	Hind foot, without claws.	* Forearm.	Thumb and claw.	Longest digit.	Metacarpal III.	Metacarpal V.	Greatest expanse of wings.
Male, Cheddar, Somerset (T. A. Coward), 5th Jan. 1907 .	66	23	15×8·75	33	24·5	10	54·5	6	85	36·75	39	..
Male, do. . .	61	22	14·25×8·5	32·5	25	11	53·5	6	82	34	38·5	..
Male, do., 7th Jan. 1907	67	22	15×8	33	24	12·75	55	6	87·5	36	38	330
Male, do., a little dried	61	21·5	14×8	34	24	11·5	51	6	75	34	38·5	312
Male, do. . .	65	22	15×8	33	25	11	54·5	6	82	38	41	342
Male, do. .	65	23	15×8	36	25	11	54·5	6	87	36	40	342
Male, do. . .	61	21	15×8	30	23·5	11·5	53·5	7	85	36	39	342
Male, do. .	60	22	15×8	32	25	11·5	51	6	82	33	36	342
Male, do. .	65	23	15×8	33	25	11	53	6	86	35	40·25	342
Male, do. . .	61	21	14×8	33	25	11	54	6	83	36	39	330
Male, Somerset (W. Eagle Clarke) . .	63·5	22	..	33	..	..	55·5	..	..		..	330
Average of males (approximate)	63·2	22	14·7×8·1	32	24·5	11·2	53·6	6·1	83·4	35·4	38·9	334·6
Female, Cheddar, Somerset (T. A. Coward), 5th Jan. 1907 . .	64	22	14·5×8	33	24·5	10·5	55	6	84·5	35·5	39·5	
Female, do., 7th Jan. 1907	69	22	13×8	33	26	13	54	7	88	37	42	340
Female, do. . . .	63	22	15×8	34	25	11·5	54	7·5	87·5	37·5	41	355
Female, do. . .	68	21·5	14×8	32	25	13	54·5	7	84	37	41	350
Female, do. . . .	65	23	14×8	34	26	11	55	7	85	34	39	355
Average of females (approximate)	65·8	22·1	14·1×8	33·2	25·3	11·8	54·5	6·9	85·8	36·2	40·5	350

* Andersen gives forearm of thirteen specimens of both sexes as averaging 55·4, with extremes of 58 and 53·8.

The female is, as in many other bats, slightly the larger sex (compare also the weights on next page).

The dimensions of a newly-born young male were as follow, *in inches:*—head and body, 1·56; tail, ·62; ear, ·37; longest digit, ·93; forearm, ·87; lower leg, ·68; expanse, 4·56 (Whitaker in MS.). Young of ten days age have an expanse of 190 to 210 mm. (Rollinat and Trouessart).

Proportionate lengths:—Foot, with claws, about ·45 to ·46 of lower leg; fifth metacarpal, about 1·09 to 1·11 of third; lower leg, about ·45 to ·46 of forearm, about ·38 of head and body, and about ·76 of tail.

Skull:—Greatest length, 24; basal length in middle line, 19·1 to 19·4; palatal length in middle line, 8; from posterior border of m^3 to

anterior border of canine, 8·8; greatest breadth at zygoma, 12·2; breadth at constriction, 2·6.

Weight in grammes:—Fourteen males averaged 20·4, the extremes being 23·6 and 17·3: one female weighed 28·1 (Charbonnier in MS.).

Distinguishing characters:—*R. ferrum-equinum* cannot be confused with any other British bat. The nose-leaf marks its genus, and the length of the forearm, always over 50 mm., its species.

The two Horseshoe Bats were, by the earlier naturalists, regarded as mere varieties of a single species, and the credit of properly distinguishing them in this country belongs to Montagu, who was also the first to discover the smaller species as a member of the British fauna.

The larger bat was first made known as a European mammal by Daubenton, and as a British species by Latham, the latter of whom supplied Pennant with an account of it from specimens taken in the saltpetre houses of the Dartford powder mills in Kent.

All the members of the singular family to which the present species belongs are distinguished by the possession of a complicated cutaneous development upon the nose, and it is to the shape of the anterior portion of this organ that the Horseshoe Bats owe their name. It is not easy to explain the precise use of this very remarkable structure, but it seems unnecessary to adopt any of the highly ingenious theories which have been advanced to account for its presence. It is quite consistent with probability, and indeed almost indisputable, that the membranous expansions which are the property of the leaf-nosed or large-eared bats, are in some way instrumental in the execution of those marvellous passages through narrow or intricate places, of which these creatures are past-masters, and for the performance of which their eyes can be of little service. No one who compares the motions of a Horseshoe with those of a typical bat can fail to be struck by the marked contrast between them. Active and alert as all bats undoubtedly are, even when liberated in a room to which they are complete strangers, yet the majority make repeated mistakes, and, as has been more than once remarked, will fly against the glass of a window, or strike it with their wings. A Horseshoe, on the contrary, if liberated in a room, and with its attention not otherwise occupied, as when in pursuit of its prey, avoids

with perfect ease all sorts of objects, and, being able to instantly detect the presence even of an almost invisible obstacle such as glass, will examine a window pane, as if in search of some means of escape, yet without so much as a touch of a wing. When it is considered that the glass would appear to be—as regards the sense of vision—equally perceptible to the one bat as to the other, an experiment of this kind becomes particularly interesting, tending, as it does, to show that a high development of the cutaneous system is, in the Horseshoes, accompanied by a correspondingly acute perception of the environment.

The habit of flying about low down in a room, and amongst the legs of tables and chairs, is so characteristic of these bats that it immediately impresses itself upon the observer. It is not unlikely that it has some close connection with the flightless insects, beetles and spiders, which, as Mr T. A. Coward has shown, form a part of their diet. Not (as mentioned above) only do these bats show great alertness in avoiding obstacles to their flight, even in a place to which they are strangers, but when at rest they display a remarkable power of perceiving an approaching danger, even when it is behind them, or otherwise at such a distance as to be out of the range of their necessarily limited vision. In this connection, Mr Charles Oldham says :—

"Even when sunk in their winter sleep, they appreciate a man's approach. The eyes are, of course, then shrouded by the wings and the sense of danger must be conveyed to them either by hearing, smell, or, as seems to be most probable, by the exercise of their extraordinary tactile sense which enables them to actually feel the approaching danger. I have often, whilst still some paces from it, watched a sleeping bat of this species raise and lower its body by flexing the legs and twist it from side to side with a jerky, spasmodic action. The enveloping wings are meanwhile slowly relaxed and unfolded; then suddenly the bat drops from its foothold and flits away into the recesses of the cave."

It is remarkable that, although thus alert and active to such a surprising degree, the senses upon which a Greater Horseshoe relies for its information in regard to the outer world are not those of sight or smell. Mr Bruce F. Cummings[1]

[1] *Zoologist*, 1907, 292.

found that, whereas the fumes of camphor or ammonia and the glare of a strong acetylene lamp passed unnoticed, the rattle of a cup and saucer, or the passing of a finger gently over his own forehead, at a distance of nine inches, put a bat of this species at once on the *qui vive*.

It is probable, then, that, apart from the generally sensitive condition of the wings and membranes, the sense of hearing is the most important aid in the capture of their prey by these bats. Mr Coward found that a large beetle was imperceptible to his captives at a distance of only two inches, and so long as it remained quiet, attracted no attention unless it was actually touched. But directly it buzzed the result was very different. A bat's attention was at once attracted and the beetle pursued and captured.

If the flight is characteristic, the method of alighting is equally so. In the words of Mr Oldham,[1] the ordinary procedure of other bats, when alighting on a vertical surface, such as a wall, a picture-frame, or a curtain, is "by pitching head uppermost. They then shuffle round instantly, and hang by their feet, in a convenient posture for another flight. But the Lesser Horseshoe Bat[2] is infinitely more adroit. Immediately before it reaches the wall, or the object on which it desires to rest, it turns a somersault, timing its action with such nicety that it clutches the object with its feet, and is at once in the attitude for taking flight again. The bat by performing this manœuvre can suspend itself, in the act of alighting, from a horizontal surface such as a cave roof, as readily as from a vertical wall. Two individuals which I had under observation used after each flight to disappear beneath a couch, where I always found them suspended from the webbing which supported the seat. By lying on the floor with my head under the couch, and then disturbing the bats, I was able, on their return, to witness this feat of aerial gymnastics, which is perhaps unequalled among the higher animals." Natterer's Bat and the Barbastelle alone in addition, so far as is known, attempt the somersault, and that feebly, and with indifferent

[1] *Mem. and Proc. Manchester Lit. and Philosoph. Soc.*, xlix., 2, 1-11, pl. and 4 figs., 31st March 1905, but the peculiarity seems to have been noticed by de Jurine at Geneva before 1800 (see *Zoologist*, 1850, 2815).

[2] These remarks apply equally to the present species.

success. So accurate is this bat's aim, and so sure its grip, that it can find sufficient inequalities for a hold on objects from which other species would inevitably slip off if they attempted to settle upon them. Mr Coward, for instance, has observed one alighting upon a smooth brass rod, and on the almost imperceptible edge of wall-paper, at its junction with a cornice.

Unlike other species, neither of the Horseshoes is capable of walking on a flat surface. Yet in captivity they have no objection to alight on the flat. On such occasions their only mode of forward progression is by a series of awkward leaps of an inch or two in length: these are made with the wings half spread, and the legs extended helplessly backwards, and end in a thud as the bat falls prone on the ground. If left to themselves, they prefer to grope behind them with their feet, and if a vertical surface be at hand, will climb it readily, ascending backwards with or without the assistance of the thumbs. But they can rise quite easily from a flat surface, leaping into flight with astounding activity, no matter how confined the surroundings. Mr Oldham has seen a Lesser Horseshoe take wing from the bottom of a box three inches deep and not more than five inches wide.

When hanging at rest in their natural attitude of suspension by the feet, these bats are very beautiful objects. The wings are draped around them in a manner not found in vespertilionid bats, but rather resembling that of certain exotic fruit bats, and so neat and ordered that it almost recalls the folding of a flower or leaf-bud. Their appearance as a whole has been likened to that of a butterfly-pupa by Mr R. Newstead, who was the first to photograph one in this attitude.[1] The legs are held perfectly straight, and, with the exception of the upper portion of the head, the tips of the ears[2] and a narrow dorsal space, the animal is completely enshrouded in its flying membranes. Sometimes the head also is covered, but a narrow space between the forearms is always exposed, this arrangement being brought about by the upper arms being laid diagonally

[1] *Zoologist*, 1897, 537-538, and plate ii. See also, Oldham, *op. cit. supra*, the present account being adapted from these two writers.

[2] In captive Horseshoes the ears may be visible, but if in really good health they are completely hidden in the wings, being slightly bent so as to fit into the natural pockets formed by the membranes (Coward).

across the back, the elbows meeting at the lumbar region, where they touch the tip of the reflexed tail: the forearms, bent sharply at the elbows, are laid lengthwise along the back so that the wrists flank the ears at either side, while the fingers with their connecting membranes are folded over the ventral surface of the body. The tail, instead of being bent forwards is reflexed over the back,[1] particularly so in the lesser species, and closely overlaps the wrinkled wings between the fifth fingers and the legs. In captivity the exposed portion of the back is usually much greater, for the wings hang every hour more loosely as the frail creature, which seldom survives capture, grows weaker.

As a bat hangs suspended when awake, it presents a good deal of animation, changing from one foot to the other, as it cleans itself, or twists and swings apparently to observe anyone who approaches. The head is full of lively action, and, as remarked by Jonathan Couch many years ago, both ears and nose-leaf appear to be very sensitive and mobile.

The Horseshoes are more partial to caves, particularly those of limestone districts, for their places of retreat, than are any other British species. But they affect also dark old buildings, lofts and roofs of dwelling-houses, as found by R. F. Tomes at Ragley, near Alcester. Their resorts, even when they themselves are hidden safely in the secure recesses of some crack or crevice, are usually betrayed by their excrement. This has in some cases accumulated so deeply on the floor below as to suggest an immemorial tenancy, an inference borne out in the case of the famous Devonshire Cavern, Kent's Hole, by the approximation in condition there of bones of the present species with those of the Mammoth, Spotted Hyæna, and Woolly Rhinoceros, as if the bats had resorted to this particular cavern at least from the Pleistocene era.

The two species of Horseshoe occur together in their favourite caverns, but in Britain the present species had been but little studied until Mr Coward made a special expedition to the Cheddar caves of Somerset, the result of which was to add many facts to our knowledge.[2]

[1] A fact observed by J. Couch before 1853 (*Zoologist*, 1853, 3941).

[2] See *Proc. Zool. Soc.* (London), 1st August 1907, 312-324; also *Mem. and Proc. Manchester Lit. and Philosoph. Soc.*, 52, xi., 1-12, pl. and figs. 1-4, 21st April 1908.

In the Cheddar caves and galleries, which are often of considerable extent, the bats hang suspended from the walls or roof, or creep into the fissures and crevices. They rest in two distinct conditions, either singly, or more frequently in groups, which may number as many as forty or fifty individuals. Even when resting in company, however, the individuals of each group, unless they happen to occupy a fissure or other confined position, do not as a general rule "bunch" together, but hang each at a small but definite distance from its neighbour.

Occasionally, however, especially in the unfamiliar surroundings of captivity, they show their social instinct by alighting upon a comrade, in which case they cling tightly to the first part that their feet may happen to clutch. Once Mr Coward saw a party hanging together from a spur of rock like a swarm of bees. They were all awake, and had evidently assumed this formation under normal conditions on the way out for their evening flight. This "bunch" rapidly dissolved when subjected to the light of a lamp.

Mr Coward's observations as a whole corroborate those of Monsieur H. Gadeau de Kerville, who writes of the present species in Normandy, where it is, with the Pipistrelle, one of the commonest bats, a colony having been found to include no less than one hundred and eighty individuals.

M. Kerville has published an interesting photograph taken by flash-light, of a sleeping colony composed of about eighty individuals.[1] He finds, however, that, even in the rather cold climate of Normandy, the sleeping colonies wake up at times and disperse to other portions of their cavern. But he is unable to say whether all the individuals, isolated and grouped, alter their positions, and whether the colony, when re-formed in a new position, is composed of the totality of individuals of which it had previously consisted, or of a greater number. He is inclined to believe, without laying stress on the point, that the re-formed colonies consist of smaller numbers.

Other French writers, Messieurs R. Rollinat and E. L. Trouessart,[2] writing from the Department of Indre, find this bat (as is frequently the case in England also) in summer

[1] *Naturaliste*, 15th October 1891, 239 and plate (seen in reprint).
[2] *Mém. Soc. Zool. de France*, 1897, x., 114 and 121.

deserting the caves in which it has spent the winter, and installing itself in small parties in churches and deserted mills. After an hibernation uncertain and liable to interruption by any unusually warm days, it issues forth on mild March days, and frequents, with low and clumsy flight, with momentary accelerations, the corners of woods and parks, the sides of high hedges, or the courses of winding streams and rivers.

Similarly, in England the bats probably do not hibernate, at least in any strict sense of the word, but are active, and feed whenever the weather is mild, and even in time of frost may shift their positions within the caves, both when disturbed and on their own initiative; in winter they prefer a position at some distance from the entrance. On these points Mr Coward writes that not only did they change their position, but that colonies which he visited on several occasions gradually diminished in numbers and finally disappeared, having apparently been disturbed by his presence, though the bats themselves were not actually molested; one colony consisted of forty on 29th December; on the 31st, when visited after sundown, it contained only eight, and two of these flew out of their own accord. On 3rd January the spot was unoccupied, and no bats made use of this particular position during the four following days on which he was able to watch them. Another colony, consisting of two companies of twelve and eight respectively, was two days later reduced to ten, and on the following day to four. A third colony of forty or fifty was similarly reduced on a second visit. Mr Coward found that the bats, at the end of December and beginning of January, were not hibernating; they woke without artificial stimulus in the caves, took wing, and actually left the caves of their own accord, apparently to feed. Messrs Coward and Oldham watched bats emerge from a hole in one cave, and pass out between 4.40 P.M. and 5.20 P.M. on 5th January, and Mr Cummings observed the same thing at Barnstaple, Devonshire, in December and January.

Mr Coward's notes, although prolonged a week further by Mr Cummings's[1] experience near Barnstaple, extend only to 16th January. Detailed records for the succeeding months are not yet available, but Couch's account of a Greater

[1] *Zoologist*, 1907, 288-294.

Horseshoe taken on the wing in Cornwall[1] on 11th January, and Mr F. C. Rawlings's specimen shot at Barmouth on 5th February, deserve mention. The internal temperature of the caves visited both by Mr Coward and Mr Cummings seemed to be fairly even, varying between 50° and 52° Fahrenheit, and it is believed to be about the same throughout the year.

Mr J. G. Millais aptly describes this species as sailing and fluttering with visibly broad wings and delicate butterfly flight, but seldom rising to any height in the air. His statement, however, that it appears at a rather late hour in the evening will possibly need correction in view of Mr Coward's observation that it began to fly at 4.40 P.M. in mid-winter at Cheddar.

There can now, I think, be little doubt that the Horseshoes do not, like most other bats, consume their prey while on the wing, but habitually alight to eat it, conveying it for this purpose to certain favourite dining-places within the shelter of the caves. These, even when the diners are absent, are betrayed by the débris of wings, elytra, and other fragments, as well as by the heaps of excrement which fall to the ground during and after a meal. The extent of these refuse-heaps indicates that the bats have strong preferences for certain spots, to which they return time after time. This fact was first mentioned by Mr A. H. Macpherson,[2] but has been insisted upon by Mr Coward. The latter naturalist finds that the ordinary food of the larger species consists of big beetles and moths, and the condition of the refuse-heaps leads him to infer that the beetles form the bulk of the winter repasts, while in summer beetles and moths are consumed in about equal numbers. Besides these, the remains of flies of more than one size and species have been identified from the refuse-heaps, and the presence therein of portions of certain flightless beetles, hibernating moths, and of a large cave-haunting spider,[3] led him

[1] *Zoologist*, 1853, 3941. [2] *Ibid.*, 1887, 262.

[3] The following insects are also mentioned by Coward as forming part of the diet:—the large beetles *Melolontha vulgaris* of Fabricius, *Geotrupes spiniger* of Marsh, and *G. stercorarius* of Linnæus; a staphylinid beetle of the genus *Quedius;* the flightless beetle *Nebria brevicollis* of Fabricius, and a *Pterostichus;* a geodephagous beetle, perhaps of the genus *Amara*, and, perhaps, a *Dytiscus;* the moths

from the first to suspect that this bat may habitually take some at least of its prey while at rest.

The habits of the Greater Horseshoe, as observed by Mr Coward, in captivity, were very instructive. "On one occasion a bat dropped near a beetle which had buzzed, for undoubtedly the buzzing of a beetle at once attracted the bat's attention; the bat moved its head to and fro, the lower edge of the horseshoe touching the floor. The beetle walked a few inches away, and then again attempted to fly; instantly the bat followed it in a series of little jumps, really short flights of a few inches, and after two or three jumps reached and fell upon the beetle, which it at once thrust into its interbrachial membrane. Directly it had secured the beetle it rose from the floor, flew to a customary perch and, there hanging, consumed it. In the cage the method was similar; the bat dropped on to the floor of the cage, lying with extended wings, and either feeling or smelling round—at least that is what the action suggested—until it found a beetle; directly one was secured, it sprang up, turned in the air, and clutched the bar of wood, only twenty inches above it, with its feet. The beetle was then pushed into the wing as usual, and the head and perhaps other fragments dropped. This, then, is evidently the way in which flightless beetles and spiders are caught, and possibly coprophagous beetles may be thus picked up when they are crawling over dung.

"This is, however, not the only way in which the Greater Horseshoe secures its food; it can and does catch insects on the wing. *G. typhœus* is a beetle which flies during mild weather in winter, and when I released a dozen beetles in my room in the evening, two or three would quickly attempt to fly. It was when this occurred that I felt certain that the bats hunt and locate their prey mainly by means of their acute hearing. The deep booming buzz of the flying beetle at once roused the

Scotosia dubitata of Linnæus, *Gonoptera libatrix* of Linnæus, *Triphœna orbona* of Fabricius, *T. pronuba* of Linnæus, and *Xylophasia polyodon* of Linnæus. Several *Diptera*, including *Muscidæ* apparently of the genus *Lucilia;* a wasp-like *Hymenopteron*, and caddis-flies. Numerous pellets of excrement were carefully examined for Coward by R. Newstead, to whose identification many of these names are due. No doubt many other insects might be added, and the moths *Triphœna fimbria* and *Agrotis saucia* were identified by J. E. Harting for Macpherson (*loc. cit.*).

Horseshoes to activity, even when, as was often the case after eating two or three beetles, their heads were drooping, and they were relapsing into sleep. Usually the bat left its foothold immediately the beetle began to buzz, and as these beetles are not always quick in getting on to the wing, the bat frequently skimmed over and missed its prey. But when the beetle had risen two or three inches from the ground, it was doomed; the bat came down like a falcon stooping, and with marvellous precision caught the flying beetle in its jaws, and carried it off to some place where it could pitch and devour it. For several weeks this performance was repeated on an average two or three times each night, and though on a few occasions the beetle got well into the air before it was captured, by far the greater number were secured before they had risen many inches from the ground."

In feeding, the Horseshoes differ from the typical bats in one marked particular. The interfemoral membrane being too small for use as a pouch, they usually requisition the posterior part of the wing to enable them to hold an insect of troublesome proportions. When dealing with a beetle, Mr Coward's bats always fluttered their wings rapidly, as if almost worrying it with the rapid movements of the head. These movements recalled the vibration of an insect's wings rather than the ordinary struggle of a bat when held in the hand. The process was first observed by Mr Coward in his captive specimens. A large beetle was thrust into the natural bag, the claws of the corresponding leg "were usually released from their hold, and the whole wing brought suddenly forward, by simultaneous stroke of arm and leg, to meet the head. The beetle was practically beaten against the membrane by rapid movement of the bat's head, assisted by the forward stroke of the wing. This wing-action, suggestive of the uses of a hand, has no exact parallel in the apparently similar use of the interfemoral pouch by vespertilionid bats. The beetle was moved by the bat against the membrane, for its position in the mouth had frequently to be shifted before the bat could devour the abdomen and reject the head, and sometimes the action of head and wing together actually pushed the beetle further into the mouth. When the beetle was first seized the wings of the bat were

only slightly unfolded, held free but with the membrane partially hiding the body, and when the bat took a beetle from the hand it beat rapidly with both arms but did not grasp with the thumb. Directly the beetle was in the bat's jaws the wings were further opened, and hung quite loosely whilst the beetle was being devoured.

"After a few seconds the head was withdrawn from the wing and the beetle masticated; the rejected portions fell, and the bat, generally suspended by one leg, swung from side to side. This swinging round was even more remarkable when both feet were attached to some hold; the animal could then turn almost completely round, crossing its legs, without altering the position of its feet. When the beetle was finished, the bat usually bent forward, and two or three times touched the object from which it was suspended lightly with its lips; this was especially noticeable when a bat had been feeding when hanging from my hand. Frequently, also, one leg was brought forward, and the teeth scratched or the lips combed by the claws, probably to get rid of some particles of beetle which were sticking to the teeth or lips.

"When the beetle was quite finished, and the subsequent performances had been gone through, the bat hung, bending its whole body forward, turning from side to side, and moving its head, ears, and nose-leaf with great rapidity; it appeared to be looking for food, but perhaps searching for prey would be a more correct way of expressing it."

At first the number of beetles eaten per bat was from five to eight each night, but later, when they were regularly feeding themselves, they took as many as ten or twelve, and even occasionally sixteen in a night. The quantity eaten did not depend upon the number left in the cage, for frequently beetles were untouched in the morning; this may, however, have been due to inability on the part of the bats to find and secure them all.

"The Horseshoe drinks by lapping with the tongue. It is a thirsty animal, and we can only suppose, from its behaviour in captivity, that it obtains water in its natural state; possibly, like other bats, it hovers over pools of water and laps whilst on the wing."

Mr Coward's captives afforded him an opportunity of ascer-

taining the position of the curious reduced interfemoral membrane and tail. During the whole process of pouching and eating a beetle the posterior portion of the tail remained in the characteristic recurved position.

"This reflexed tail (writes Mr Coward), or to be more exact, portion of the tail, is constantly in this curious position. In flight the anterior portion of the interfemoral membrane is stretched between the slightly flexed legs; the end of the tail is upturned;[1] and when the bat is scrambling or climbing, the tail is held in the same position; when at rest the tail is flat upon the back if the wings are half-open, or lies partially concealed by the forearms if the animal is closely wrapped in its wings."

The sounds made by this bat are variable. Mr Coward compares its voice to a sparrow-like chirp or chattering, while Mr Millais describes it as a somewhat subdued squeak, louder in the young, which, when clinging to their mothers or following them about when nearly full grown, keep up a constant high-pitched double cry. Two which he kept in his own house maintained this cry, apparently without ceasing, throughout the day and night.

It seems probable that, though not without exception, the sexes keep their own company. This was Mr Coward's experience, and it is also possible that, as suggested for the Lesser Horseshoe, there is an actual disparity in their numbers, the males being more plentiful. In France, according to Messrs Rollinat and Trouessart, the pregnant females unite to form more or less numerous bands in April, and do not separate until they have reared their young. They are frequently accompanied by a few non-breeding young of both sexes, and even, very often, by adult males.

Messrs Rollinat and Trouessart have published an interesting account of the breeding habits.[2] They find that the pairing season is in autumn, but that fertilisation, and consequently the true period of gestation, does not commence until the resumption of the period of activity in spring. This varies with the vigour of the individual and the situation of its winter

[1] Cummings corroborates this point, *loc. cit.*, 291.

[2] *Loc. cit.*; also, *Comptes rendus Soc. Biol.*, 26th January and 6th July 1895, 53-54, and 534-536 (reprints).

retreat, so that the date of birth of the single[1] young is uncertain. The first, however, appear about the 20th June, after a period of gestation lasting ten or eleven weeks; the last are probably born before the end of July.[2]

The young are carried about by their mothers, attached to the false nipples by their teeth. When they are hungry they transfer their hold to the true nipples, and on the milk derived thence they are nourished for a period, estimated from the analogy of the Mouse-eared Bat, of about two months. They grow rapidly, and by the middle of September are nearly as big as their parents.

The attitude of the young one, clinging as it does by its teeth to the false nipples of its mother, differs in a marked particular from that of the typical bats. Its wings lie close to its mother's abdomen, its feet cling one to each of her flanks, its tail, with the tip recurved as in the adult, stretches near her neck. The result is that, as the mother hangs head downwards, the little one's head is uppermost, a position unique amongst British bats.

Mr Coward's observations have done much towards dispelling the deep ignorance hitherto prevailing in regard to the habits of one of the finest and most remarkable of British bats. He was, in fact, the first English naturalist who succeeded in keeping it alive in captivity, in one case for a period of nine weeks.

There are some curious myths circulating amongst continental naturalists, some of whom have stated that the Horseshoes sometimes suck the blood of sleeping birds and mammals. Fatio even quotes without disapproval Kolenati's statement that the present species roams by night with criminal intent amongst birds'-nests, or haunts for sinister ends the rocky mountain refuges of the Chamois.

The large size, broad wings, and curious butterfly-like flight should make this species easily recognisable.

[1] Note, however, that in Germany Kuhl found two, sometimes one (see above, p. 231).

[2] Arthur Whitaker had one born in captivity on 14th July.

THE LESSER HORSESHOE BAT.

RHINOLOPHUS HIPPOSIDEROS (Bechstein).
RHINOLOPHUS HIPPOSIDEROS MINUTUS (Montagu).

1760. LE FER-À-CHEVAL, L. J. M. Daubenton in E. L. le Clerc, Comte de Buffon's *Histoire Naturelle*, viii., 131-133, pl. xx., figs. 1 and 2; also, *Mém. de l'Acad. Roy. des Sci.*, 377, 382, pl. xv., fig. 4, 1759, published 1765; described from France.

1774. VESPERTILIO FERRUM-EQUINUM (in part), J. C. D. von Schreber, *Die Säugthiere*, i., pl. lxii., two lower figures, 174, 190; evidently naming Daubenton's *Le Fer-à-cheval;* Montagu, *Transactions Linnean Soc.* (London), ix., 162, 1808; Bingley; Clermont.

1776. VESPERTILIO EQUINUS (in part), P. L. S. Müller, *Natursystems Supplements und Register Band*, 20.

1785. VESPERTILIO UNGULA (in part), P. Boddaert, *Elenchus Animalium*, i., 71; renaming Schreber's *V. ferrum-equinum.*

1788. VESPERTILIO FERRUM-EQUINUM, β. minor, J. F. Gmelin, *Systema Naturae*, i., 50.

1792. VESPERTILIO FERRUM EQUINUM MINOR, Robert Kerr, *Animal Kingdom*, 99 (not *V. molossus minor* of Kerr, *op. cit.*, 97); described from France.

1797. NOCTILIO HIPPOSIDEROS, J. M. Bechstein, *Der Zoologe*, I., i.-viii., 65.

1798. VESPERTILIO HIPPOCREPIS (in part), F. von P. Schrank, *Fauna Boica*, i., 64.

1800. VESPERTILIO HIPPOSIDEROS, J. M. Bechstein, in *Thomas Pennant's Allgemeine Uebersicht der vierfüssigen Thiere*, ii., 629 footnote, see also 615 and 736; Donovan.

1803. RHINOLOPHUS MINOR, Étienne Geoffroy, *Catalogue Mammifères Mus. d'Hist. Nat.* (Paris), 57; described from Paris.

1804. VESPERTILIO (? RHINOLOPHUS) HIPPOCREPIS, Johannes Hermann, *Observationes Zoologicae*, 18.

1808. VESPERTILIO MINUTUS, George Montagu, *Trans. Linnean Soc.* (London), ix., 163, etc.; described from Devonshire, England; Pennant, ed. of 1812, 181, i., pl. xiv., figs. 3 and 4.

1813. RHINOLOPHUS BI-HASTATUS, Isidore Geoffroy, *Ann. du Mus. d'Hist. Nat.*, xx., 259; renaming Daubenton's *Le petit Fer-à-cheval.*

1816. PHYLLORHINA MINUTA, W. E. Leach, *Systematic Catalogue of the Specimens of The Indigenous Mammalia and Birds that are Preserved in The British Museum*, etc. (London), 1; named, without description, from Torquay, Devon.

1817. RHINOLOPHUS HIPPOSIDEROS, W. E. Leach, *Zoological Miscellany*, iii., 2, sp. 2, pl. 121, *et plurimorum auctorum.*

1829. RHINOLOPHUS BIFER, Jakob Kaup, *System der Europäische Thierwelt*, i. 104; without description, hence a *nomen nudum.*

1862-63. RHINOLOPHUS HIPPOSIDEROS, var. TYPUS, ALPINUS, et PALLIDUS (in part), Carl Koch, *Jahrbücher des Vereins für Naturkunde im Herzogthum* (Nassau), 530-531; described vaguely and "scarcely determinable" (Andersen).

1885. RHINOLOPHUS BIHASTATUS, var. KISNYIRESIENSIS, Daday Jeno, *Orvos-Természettudományi Értesitö*, etc., x. (3), 274; described from Kis-Nyires, Transsylvania.

1887. RHINOLOPHUS HIPPOSIDEROS var. TROGLOPHILUS, Daday Jeno, *Értekezések A Természettudományok Körébol* (Budapest), xvi., Nos. 7, 8, pl., figs. 1 and 2, 1886; described from Kis-Nyires, Transsylvania.

1891. RHINOLOPHUS HIPPOSIDERUS, Blandford; Flower and Lyddeker; Johnston.

1905. RHINOLOPHUS EURYALE HELVETICA, K. Bretscher, *Vierteljahrsschrift der Naturforschenden Gesellschaft* (Zürich), xlix., 256, 1904; thus identified by Andersen.

1905. RHINOLOPHUS HIPPOSIDERUS MINUTUS, Knud Andersen, *Proc. Zool. Soc.* (London), 17th October, 142; Trouessart (1910).

Synonymy:—The Lesser Horseshoe Bat was first recognised as distinct on paper by J. F. Gmelin in 1788, and was formally named by Bechstein in 1797. It was discovered in Britain by Montagu, who wrote an elaborate paper describing its specific characters. The name which he proposed for it—*Vespertilio minutus*—is antedated as applied to the species as a whole by Bechstein's *hipposideros*: having been based, however, upon English specimens, it is available for the British race as differentiated by Andersen (see *Ann. and Mag. Nat. Hist.*, Dec. 1905, 648-662; and *Proc. Zool. Soc.* (London), 17th October 1905, 142).

A curious instance of the possibilities resulting from strict adherence to rules of nomenclature suggests itself by Gmelin's use of the words major and minor. He clearly did not intend to apply them subspecifically as such, but, writing in Latin, he used the words descriptively. Nevertheless, strict adherence to rule might conceivably disregard his intentions, and, considering only the form of what he wrote, assign these names to the two bats which he had in view. In that case *Rhinolophus major* would become a synonym of *R. ferrum-equinum*, but *hipposideros* would give place to *minor*. I find no rule governing this instance laid down in any code of nomenclature, and, until such rule be made, I shall not venture to adopt an alteration so inconvenient.

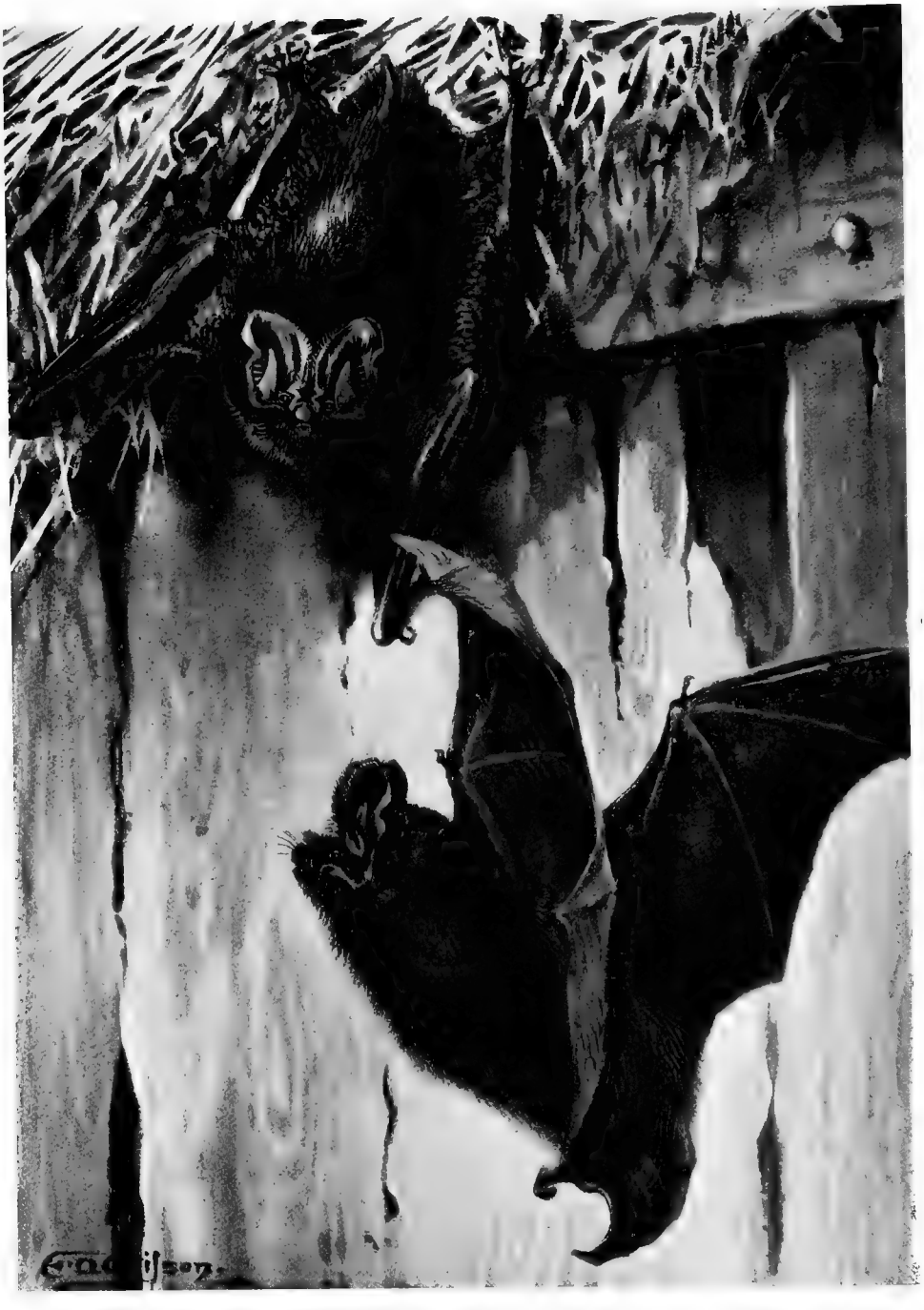
Distribution:—*R. hipposideros* ranges from Ireland to Gilgit, and from the Baltic to Sennaar, Africa. It ascends the warm valleys of the Himalayas to at least 6000 feet in summer. It is divided by Andersen into three closely allied sub-species, viz., Heuglin's *minimus*, inhabiting the Mediterranean region, Egypt excepted, with the Balearics, Malta, Corsica, and Crete, to Sennaar and Keran; *hipposiderus* (*sic*) proper, of central Europe north of the Balkans and Alps with Cyprus, through north-west Persia and Armenia to the extreme north-west Himalayas; and Montagu's *minutus*, of the British Islands. The distribution in France, as given by Rollinat and Trouessart (*Mém. Soc. Zool. de France*, x., 125, 1897), may fitly be compared with the British. Although inhabiting the whole country it becomes rarer in the north-east, but is very common in the south-east, south, centre, and west.

The British distribution of *R. hipposideros* repeats and amplifies the

features of that of *R. ferrum-equinum*. Thus, while quite unknown in east Anglia and rare in the Midlands, it is common in many parts of the south of **England** from Kent westwards, is widely distributed in the west and in **Wales**, and may be said with certainty to range as far north as Ripon in Yorkshire. The eastern boundary of its English range is thus roughly crescentic, the tips of the crescent resting on Kent and Yorkshire. Furthermore, the bat is found in **Ireland**, but here again, although stated to be the "Common Bat" of parts of the west, where it occurs from Kerry north to Galway, it has never been detected in the east, nor, one doubtful record excepted, even in the centre.

Tracing out this crescent, H. A. Macpherson knew of a Hertford specimen, and cites Sevenoaks in Kent as one of its habitats (*Zoologist*, 1887, 152); while Millais has seen others from Maidstone and Chiselhurst, and, with Ogilvie-Grant, has frequently observed it in Kensington Gardens, London, whence a specimen was identified by Harting; Tomes found it at Godstone, Surrey (Bucknill and Murray); but no records are forthcoming from Sussex; and Hart knew of only one Hampshire specimen (Trevor Battye and Lascelles); while another reported to Kelsall as having been taken at Niton in Wight many years ago (*Zoologist*, 1887, 90) would appear to be the solitary record for that island. The former records are additional to the information collected by Kelsall in 1887 (*loc. cit.*), at which time the species had no known habitats in the south-east of England. Its absence from Essex, Suffolk, Norfolk, Cambridge, Lincoln, Bedford, Rutland, and Huntingdon can hardly be due to oversight in the face of the presence in these counties of a long succession of naturalists, including Laver, Rope, Caton Haigh, and Cordeaux. The first-named in particular has, as he positively assures me, in a lifetime devoted to the study of the local fauna, never seen nor even heard of a local specimen, so that Millais's statement that he has "seen specimens from Colchester" would seem to need confirmation.

In the south-west the species was discovered by Montagu in Wiltshire in two localities (*Trans. Linnean Soc.*, ix., 1808, 162-171); and afterwards (with *R. ferrum-equinum*) in Kent's Hole, an extensive limestone cavern near Torquay in Devon, and it has since been encountered frequently within the county borders (see Jordan, *Zoologist*, 1843, 75; Borrer, *Journ. cit.*, 1874, 4129; Lilford, *Journ. cit.*, 1887, 63; Hollis, *Journ. cit.*, 1907, 110-111). Further records up to 1887 have been summarised by Kelsall (*loc. cit.*), showing that it occurs, often abundantly, in Cornwall (see also Couch, *Journ. cit.*, 1853, 3941, and Millais), sometimes indeed, almost to the exclusion of all others (Clark); in Somerset, where the Mendip Caves may be mentioned as a specially favoured haunt (see also Lewis, *Journ. cit.*, 1906, 69, and Millais); and in



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Dorset. North of 51° 30′ north latitude its numbers become uncertain, and, although stated by Tomes to be not rare at Cirencester, Charbonnier and Lloyd Morgan report it as scarce at Bristol, and seldom obtained north of the Avon. I know of no records either for Oxford or Buckingham, and of one only for Berkshire (Cocks, *Journ. cit.*, 1906, 186); so that the bat is practically unknown from Cirencester eastwards to the North Sea.

The species is, however, by no means entirely southern in its distribution, since it appears again across the Bristol Channel in Monmouth, where Donovan found it at Raglan Castle in 1802, and thence it is widely distributed to the extreme north of Wales and in the north-east to Ripon in Yorkshire, but is rare or absent from the central English counties south of the Wash. The details are worth noting:—It has been found by Storrie at Bridgend in Glamorgan (Kelsall); by Tracy frequently at Stackpoole (Kelsall); by Proger (specimen sent to Forrest) at St David's in Pembroke; by Lingwood at Sufton (*Ann. and Mag. Nat. Hist.*, May 1840, 185); by Wallis near Ross (*Trans. Newcastle-on-Tyne Nat. Hist. Soc.*, xi., 243, 1894); and by Hewitt, who sent a specimen from Ledbury; all in Hereford. It has been noticed sparingly in many parts of Merioneth by Caton Haigh, who believes it to be generally distributed in North Wales (*Zoologist*, 1887, 152). Further north, Oldham has detected it in Carnarvon (*Journ. cit.*, 1903, 430); and Newstead, Caton Haigh, Oldham and Coward in Denbigh and Flint (*Journ. cit.*, 1887, 152; 1896, 255; 1897, 537-538; 1906, 70-71). Towards the east there is only one known Shropshire specimen, that in the Worcester Museum; it flew into Steele Elliott's house at Dowles on the Worcester county border on 6th July 1904 (*Journ. cit.*, 1905, 308); Coward, however, found it in the Ceiriog Valley in Denbigh, four miles from the Shropshire border, in 1900. Tomes rates it as by no means rare in Worcester, and local rather than rare in Warwick; Millais has examined a single Stafford specimen, and Hardy one from Edwinstowe, Nottingham (Kelsall), while Cheshire has one very doubtful record, dating from 1834 (Coward and Oldham). In Derby it is found in fair numbers, chiefly in limestone caverns and old lead workings at Matlock, and in the surrounding country even as far as the Peak district. It appears to be absent from the Trent valley and the basin of the lower Dove (Jourdain). In Yorkshire it was discovered by James Ingleby, from whom, in January 1876, Laver received specimens taken near Eavestone, Ripon (Roebuck, *Zoologist*, 1882, 186); Storey has also reported it from near Pateley Bridge in Nidderdale (see *Field*, 12th April 1884, 499; *Naturalist*, 1886, 339; *Zoologist*, 1895, 65), but a statement that it is the "prevailing species" in a locality so near the northern extremity of its range has not been corroborated, and would

seem to be an error. Millais states that it has been recorded from Durham and Northumberland, but it is evident that Ripon must, until further details be forthcoming, be regarded as the most northerly limit of its British range. The record by A. R. Young of its occurrence at Crookston Castle, Renfrew, **Scotland** (*New Stat. Acc. Renf.*, 1845, vii., 162), has not been confirmed (see Alston).

In **Ireland** this species was first discovered by William King in Galway in June 1858, and by Foot in Clare on 10th March 1859. The former obtained only one specimen (*Proc. Dublin Univ. Zool. and Bot. Ass.*, 15th April 1859, in Dublin *Nat. Hist. Review*, vi., 522-525); but the latter adduced strong evidence to prove that it is the common bat of the district around Ennis (*Proc. Dublin Nat. Hist. Soc.*, 1st April 1859, in Dublin *Nat. Hist. Review*, vi., 379-381).[1] These localities have since been confirmed for Clare by J. R. Kinahan (*Zoologist*, 1861, 7617-7624), and Scharff (*Irish Naturalist*, 1902, 175), and for Galway by More, by whom two specimens, taken at Coole Park, near Gort, were presented to the Dublin Museum. The bat has since been reported from Kerry by Hardy, who encountered a large colony at Muckross Abbey in July 1885 (Kelsall, *loc. cit.*, 92-93), and later from the same district by Forrest (*in lit.* of 3rd October 1905).

As noticed under the preceding species, there is an old record, dating from 1845, of the occurrence of a leaf-nosed bat of uncertain species in Co. Westmeath: this, if substantiated, would antedate all other accounts of Horseshoe Bats in Ireland.

Distribution in time:—The remains of this bat have not been recognised in the fossil condition.

The breeding season, period of gestation, and **number of young** are, according to Rollinat and Trouessart, similar to those of *R. ferrum-equinum* (see under that species); except that, owing to later emergence from hibernation, the young are not usually born so early, a fact which corresponds with Whitaker's dissection of females containing embryos nearly ready for birth on 14th and 24th July (*Naturalist*, March 1907, 74, and *in lit.*). Proger, however, saw young ones born in South Wales about 20th June (*in lit.*). He has also once observed spring courtship (see *Proc. Cardiff Nat. Soc.*, March 1905, reprint, 5, 1906), but there is no evidence of consummation.

As in *R. ferrum-equinum*, the males and females found in autumn may be divided into three classes, according to their ages, as shown by their genital organs, up to the third autumn. The authors conclude that, although well-developed in this respect, neither sex pairs until the third autumn, when they are nearly two and a half years old;

[1] Jameson, *Irish Naturalist*, 1897, 36, gives the dates of occurrences differently, but, as I think, incorrectly.

females are found still virgin until their third October, in spite of the fact that adult males have the organs in a seemingly functional condition until May.

Description:—In general appearance this bat resembles the preceding species, but its size is very much less, and its colour darker, both in fur and membranes.

The **ear** (Fig. 2, No. 11, p. 7) is rather more deeply sinuate on the outer margin, the transverse sulci are less apparent (disappearing in dry skins), and the basal lobe is larger in proportion.

In the **nose-leaf** the horseshoe is less closely applied to the head, the concentric rings, especially the median, are more conspicuous, and the sella is cuneate, not fiddle-shaped, and has its summit pointed.

In the **wing** (Plate XVII., Fig. 3) the second phalanges of digits three and four are less than one and a half times the length of the metacarpals. The fourth metacarpal is slightly the longest of the three.

The general **colour** of adults is, above, brownish "drab," with variations either towards "wood-brown" or "Prout's brown," the bases of the hairs being everywhere "ecru drab"; the underside is "ecru drab," with variations towards "drab-grey."

The wing, ear, and foot are coloured as in *R. ferrum-equinum*.

As in the last species, young individuals are as large as their parents by their first September, but are greyer, being very nearly "mouse-grey" above, with the bases of the hairs everywhere "drab-grey." The upper side is clothed with downy hair at birth (Whitaker).

In the **skull** (Fig. 26) the auditory bullæ are so large that the basi-occipital is very much narrowed between them so as to become a mere bridge of bone. Sometimes the bullæ are nearly in contact.

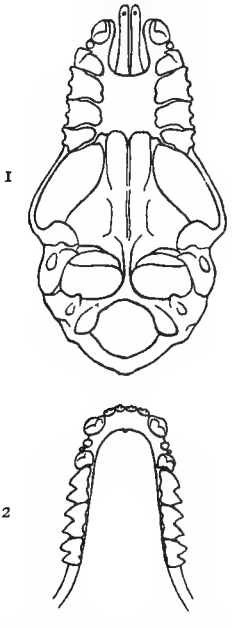


FIG. 26.—DIAGRAM OF TEETH OF *Rhinolophus hipposideros*.
(1) Upper and (2) Lower Jaw.

The anterior upper premolar, though small, is in the tooth-row, the upper canine and posterior premolar being well separated. In the lower jaw the anterior and posterior premolars are usually almost or quite in contact, the central external, but there is some variation in this respect.

The individual **variation** of this species has not been studied in any

detail. Kelsall (*Zoologist*, 1887, 93) mentions a white one, but without giving details, and two continental specimens are noticed by Cantoni.

Geographical variation manifests itself chiefly in size, the length of the forearm being 39 to 41·7 and 34·7 to 38, and of the skull 16 and 14·5 to 15·5 mm. in the typical sub-species and in *minimus* respectively. *Minutus* agrees in skull with the type, in forearm with *minimus*. The differences are slight, but constant for a series.

DIMENSIONS IN MILLIMETRES:—

	Head and body.	Ear, greatest length.	Nose-leaf, greatest length and greatest breadth.	Tail.	Lower leg.	Hind foot, without claws.	Forearm.	Thumb and claw.	Longest digit.	Metacarpal III.	Metacarpal V.	Greatest expanse of wings.
Three males (H. J. Charbonnier)	..	..	..	..	17 17 15	..	34·4 37·3 35·3	..	..	23 24 24·5	26 28 26	..
Thirty specimens measured by K. Andersen — Max.	..	15·5	10–11·8	27	18·5	8·7	39	..	..	24·9	28·2	..
Thirty specimens measured by K. Andersen — Min.	..	14·2	6–6·7	23·5	16·3	7·5	36·3	..	..	22·8	24·7	..
Female, Devonshire (1), measured in dried skin at British Museum	39	15·5	..	26	8	8·8	36	4	51	23·5	25	241
Female, do. (2), do.	38	15·5	..	28	10	10·8	38	4	53	23	26	250

NOTE:—Embryos within the mother reach an expanse of 100 to 110, and by July the young attain to 190.

Proportionate lengths:—Foot, without claws, about ·50 of lower leg; fifth metacarpal, about 1·1 of third; lower leg, about ·46 of forearm and about ·71 of tail.

Skull:—Greatest length, 16; basal length in middle line, 13·3 to 13·5; palatal length in middle line, 5·0; from posterior border of m^3 to anterior border of canine, 5·7; greatest breadth at zygoma, 8; posterior breadth, 6·8.

The **weight** of three is given by Couch (*Zoologist*, 1853, 3941), as 77, 74, and 73 grains = 5, 4·8, and 4·7 grammes.

Distinguishing characters:—The length of the forearm, always under 40 mm. in British, and only slightly exceeding 40 mm. in continental specimens, at once distinguishes this species from *R. ferrum-equinum*.

The Lesser Horseshoe is in appearance and habits to a large extent a small edition of the larger species. It is, however, more widely distributed, and was consequently the better known of the two up to the date of Mr T. A. Coward's essays

on its congener. It appears to be in every way a more fragile and delicate bat, and is to be found in greatest abundance in districts where the presence of caves affords it an equable temperature during the cold days of winter.

It is difficult to compare its flight with that of its larger congener. Although apparently slow in its movements, it is, perhaps, less so than the larger species. It vibrates its wings more frequently, but is not so graceful, and does not glide so often. Yet it is very active, since Mr Arthur Whitaker, who has effected the capture with his net of seven other species while out of doors and at full liberty, writes me that its wonderful agility completely defeated him for half an hour in the confined space of a room.

The behaviour of a Lesser Horseshoe Bat, under the novel conditions of confinement in a strange room, has been well described by the late R. F. Tomes, who remarked that it displayed in its search for a means of exit an ability which was quite extraordinary. It literally flew into every part of the room, going behind and under everything, even under a bookcase standing against a wall, although there was scarcely a space of three inches between it and the floor. Some bookshelves in a recess especially attracted its attention, and after examining them diligently, it darted into a vacancy occasioned by the removal of an octavo volume, and out again into the open room, without having been seen to touch anything even with the tips of its wings. But it was most interesting to observe it when making an examination of the window, searching every pane over and over, inch by inch, until it might properly be said that no portion of the glass remained unexamined. While doing this, the wings were kept in a vibratory state, the face of the animal being directly in front of the glass, and very near to it, as if looking out of the window. The general manners of the creature, when thus engaged, conveyed in a slight degree the idea of a hawk-moth when hovering in front of a flower. From the behaviour of the individual, and its peculiar mode of flight, it was difficult to repress the idea that it was either *feeling* its way about, like a blind person, or *feeling* for an opening by which to escape. But, at the same time, its shyness when approached gave Tomes the strong but, as it

now appears, questionable idea that its sense of sight was by no means deficient. In its habits the Lesser is not known to differ from the Greater Horseshoe, but its smaller size must necessarily affect its food, since it is not large enough to seize the big beetles on which the latter so largely subsists, but it is evidently powerful enough to capture moths. Several naturalists have found that, in captivity at any rate, it will eat the cave-spider and one or both of the cave-haunting moths;[1] and the fact that Mr Coward's captive specimens more than once alighted on a table to eat mealworms lying on it, taken in conjunction with that writer's observations on the larger species, makes it appear almost certain that both Horseshoes may habitually feed when at rest.

This bat is one of the commonest if not the "common bat" of some parts of the west of Ireland, and one of the first printed accounts of a Horseshoe bat-cave was penned in that country by F. J. Foot, in 1859.[2] This was supplemented by a further exploration of the County Clare caves, undertaken by Foot and J. R. Kinahan in 1861.[3] The caves examined were all in the neighbourhood of woods or plantations, and were the winter habitat of certain spiders, moths, and gnats. The bats did not seem to be particular as to either the height from the ground or the part of the cave where they hung. They were found suspended at all elevations, from those out of reach of a man to within two inches of the ground. Although most frequently tenanting the dark inner recesses, they were also encountered at rest in broad daylight at the entrance. They were distributed either singly or in companies, not, however, thickly crowded together, and it was shown that their lethargy, at least in March, was not so profound as to prevent them from shifting their quarters. Foot supposed that their movements must be due to alterations in the moisture of the cave, causing them to retreat to the driest parts of it, and Kinahan thought that they might feed on their insect companions. It is remarkable that of fifty-four bats, carefully and separately examined, all but four were

[1] *Scotosia dubitata* and *Gonoptera libatrix*.

[2] "Proc. Dublin Nat. Hist. Soc.," printed in Dublin *Nat. Hist. Review*, vi., 379-381, 1859.

[3] *Zoologist*, 1861, 7617-7624.

males, and of the four females two were found on 1st April at a place where on 8th March there had been four males, while another was hanging by herself in a separate part of one of the caves. Similarly, of twenty specimens examined by Foot in 1859, only one was a female. In corroboration, Mr Charles Oldham writes me that of fourteen bats taken by Mr Coward and himself from the Cefn Cave, near Denbigh, on 4th March, twelve were males and two females. Further observation will no doubt show whether the numbers of the sexes are unequal,[1] or whether Foot and Kinahan's experiences merely indicated that the adult females had departed to bring forth their young apart from the males. On the other hand, Messrs Coward and Oldham inform me that they have seen males and females hanging together in March, April, and on 2nd December. The idea that the males outnumber the females, although at first sight improbable, has gained in importance from Mr C. B. Moffat's[2] suggestion—based partly on a study of birds and insects in Ireland—that fertility may decrease and females may become scarce as the outskirts of the geographical range of a species is reached. It is quite in keeping with the known disagreement between the observations of continental and of British naturalists as regards the number of young in bats.

Another point suggested by the work of Foot and Kinahan is that, like other species, the bats are not necessarily to be found in the same retreats in summer as in winter. One cave, that of Balliallia, was entered twice in March of two different years and once in August, and, although tenanted by bats in the former, was empty in the latter month. There is, however, probably no definite rule about this habit, and the reverse was found to be the case at Cheddar, Somerset, by Mr Coward.

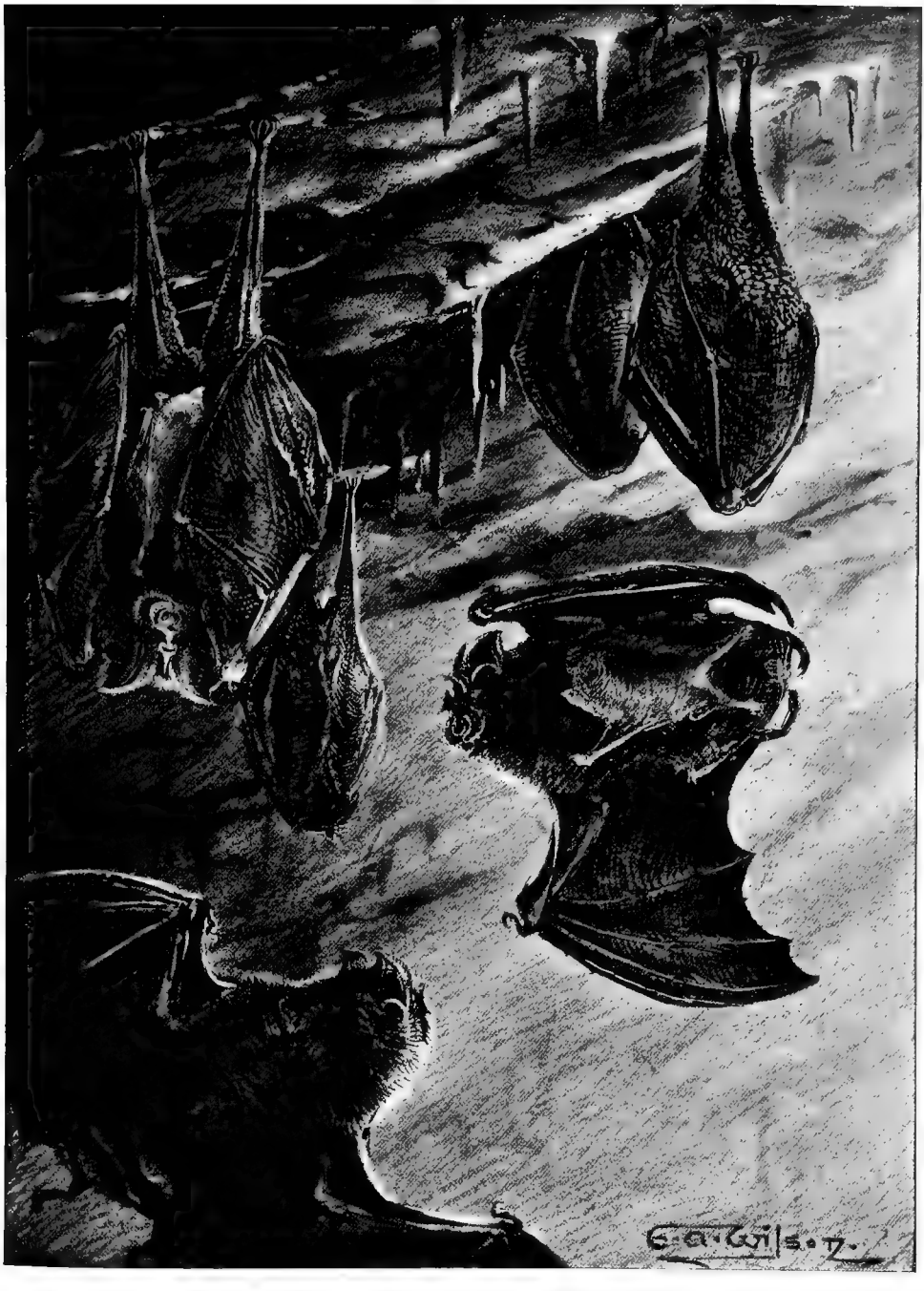
Foot and Kinahan may be said to have demonstrated with considerable accuracy the general features and characteristics of the cave-life of these bats; in fact, the only point in regard to which later observers have shown them to be in error is in the supposed necessity for woods and plantations in the neighbourhood of the bat-caves. Both Mr Coward and Mr Oldham

[1] It is suggested by E. Hollis for Devonshire, see *Zoologist*, 1907, 111.
[2] *Irish Naturalist*, 1907, 140-144.

have supplied me with independent information that they have found the bats inhabiting caves opening on to bare hillsides.

At Cefn, on 18th November, with a cave temperature of 46° Fahrenheit, Mr Coward[1] found the bats so wakeful that two were on the wing, and these were joined by three others on his disturbing them. The excrement on the ground beneath them seemed to indicate that they had fed after retiring to the cave, especially as the remains of the cave-haunting spider[2] showed that this species had formed part of their diet. Other observations to the same effect have been made by Messrs Newstead and Oldham, who have attempted to ascertain the exact duration of the winter retirement. On this point Kinahan in Clare and Mr Coward in Denbighshire found the caves untenanted in July and August, but the bats were at home in the Irish caves on 1st April, and in the Welsh ones on the 4th of the same month.[3] As regards the autumn, Mr Oldham,[4] who has had specimens taken on 24th September from a cave in Carnarvonshire, suggests that this haunt may have been occupied throughout the summer months. In any case it is clear that the bats frequent the caves where they hibernate at least from some time in November to some time in April, and that during that time they frequently shift their positions within the caves, but whether or to what extent they ever leave them is uncertain. "Even during their period of activity," writes Mr Oldham, "from spring to autumn the diurnal sleep of bats is profound. The heart beats feebly, respiration is diminished, and the temperature falls. The creature, if taken in hand, feels cold and lifeless, and some time elapses before, with sneezes and spasmodic twitchings of the limbs, it emerges from its lethargy, an epitome of restless activity and pulsating life. The phenomena of normal sleep are intensified during hibernation; but, even if other proof were lacking that the winter sleep is broken, it is highly improbable that the vital functions would be so far in suspense that food taken immediately prior to the Bat's retirement in autumn would remain unassimilated in the stomach, or as

[1] See article on Greater Horseshoe, *supra.*
[2] *Meta menardi.*
[3] In Kent's Hole, Devonshire, on the 8th (Oldham).
[4] *Zoologist*, 1903, 430.



GREATER HORSESHOE BATS.

fæcal matter in the intestines, until the resumption of an active existence in spring."

As in the case of the previous species, the observations of Messrs R. Rollinat and E. L. Trouessart in the Department of Indre, France, throw much light on the breeding habits. They find, for instance, that during the period of gestation and of rearing the young, the breeding females of these delicate creatures—the most delicate, as the authors think, of all European bats—forsake the companies of powerful Greater and Euryale[1] Horseshoes with which they have spent the winter. They are often accompanied by males of their own kind, but, apart from these, the only strangers allowed to associate with them are a few Notch-eared Bats.[2]

Unfortunately, little is known of these important matters for this country. Mr T. W. Proger[3] had one born in captivity on 20th June in South Wales, and several females which he examined were about to become mothers at that date. On the other hand, Mr Whitaker[4] found fully-developed embryos in dead females from Somerset on 14th and 24th July. The breeding season is, therefore, a long one, but in other respects is probably similar to that of the larger species. In France, Messrs Rollinat and Trouessart find that this is the case, but the winter retreats are deserted at a slightly later date, so that the period of gestation and the date of birth of the young are delayed accordingly.

In France the first young one was found with its mother on 13th July, but others had evidently been born at some time previously. The mothers, if frightened, will deposit their young in a safe place and attempt to escape without them. By 25th August lactation seems to have finished, and the young are nearly as big as their mothers, who are now in poor condition. Soon afterwards the nursing parties disperse to the caverns, where the winter is spent; in September they regain their condition, and in October they pair again.

These authors remark on the frequent presence at all seasons of very thin individuals, in contradiction to the fact that both sexes of the Greater Horseshoe are always very fat.

[1] *R. euryale* of Blasius.
[2] *Myotis emarginatus.*
[3] *In lit.*
[4] *Naturalist*, March 1907, 74, etc.

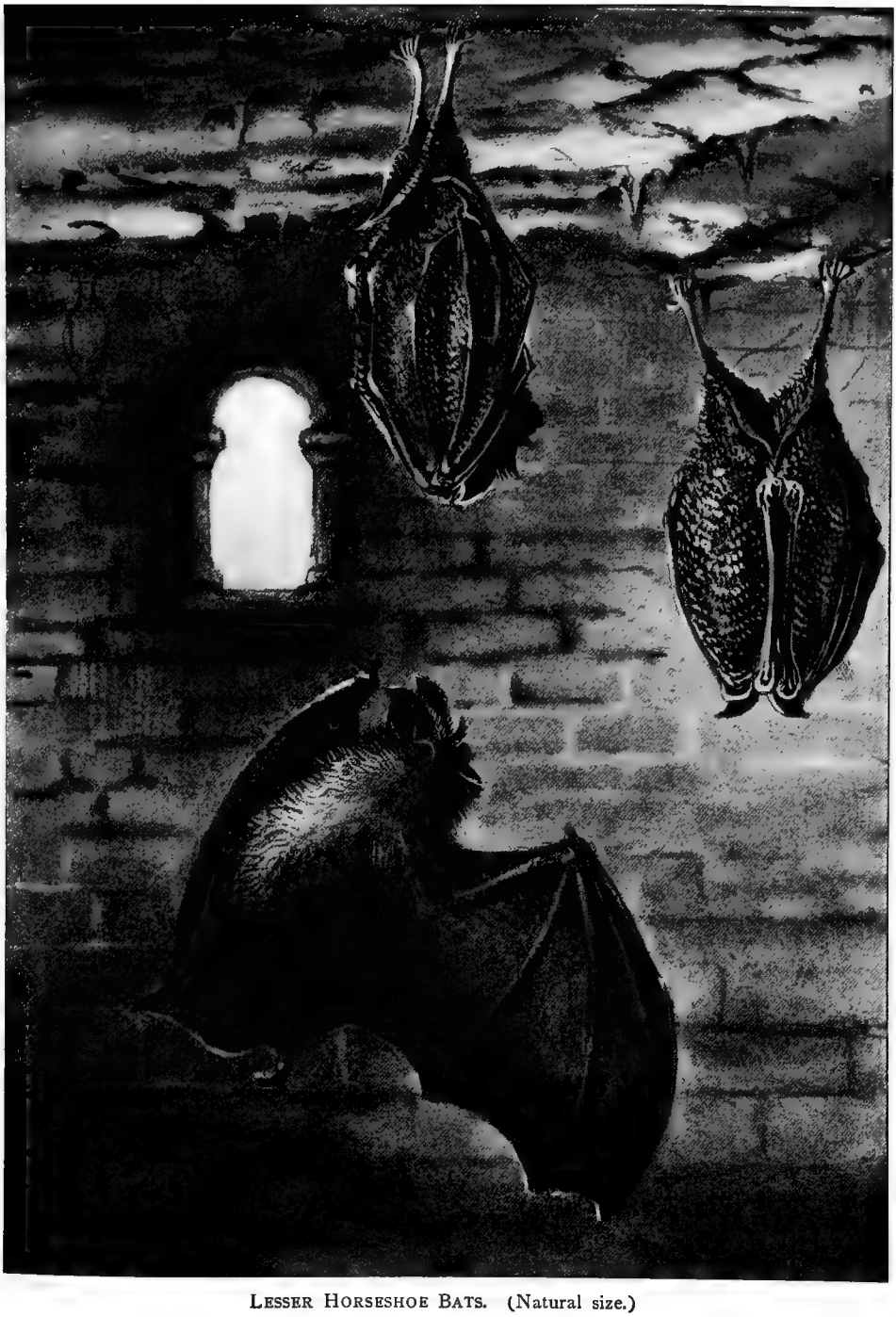
They attribute this to the fact that the Lesser Horseshoe is delicate, and does not possess very vigorous powers of flight; they have satisfied themselves that the least wind interferes enormously with its evolutions, so that it frequently remains at home and fasts at times when other species are able to catch their food.

Messrs Rollinat and Trouessart made the interesting observation that when a number of mothers and their young are placed together after capture, the young travelled from one to the other, and were received by all. This fact made the authors think that, unlike other bats, such as the Mouse-eared, the females of this species may possibly assist each other in rearing the young.

So far no one has succeeded in keeping Lesser Horseshoes alive in confinement for more than a short time. They rarely progress sufficiently in domesticity as to consent to eat, and, as a rule, pine away within three or four days' time. Writing to Mr J. G. Millais of one which he succeeded in keeping alive for four days, Mr Coward remarked that it "took readily to mealworms, after the juice of one had been smeared on its face; the first day it would eat only half a mealworm, but the next day it took six fair-sized worms and a small caddis-fly. It would not touch this fly until it had eaten the grubs. This bat found great difficulty in masticating the hard skin of the worms, its teeth being small and its jaws feeble, but it took to them well and asked for more, biting my fingers and even taking a bit of my jacket in its mouth. It drank water from the end of a camel's-hair brush, and also took a little milk." When resting on the table the tail was held above the back, and when it was struggling with a large mealworm there was no movement of the tail perceptible.

When frightened or attacked, the Lesser Horseshoe Bat squeaks loudly, and its voice has been divided by Mr Coward into two cries, the one a short, sharp "chap" or "chip," and the other a "chatter," each of much lower pitch than those of most bats. Mr Oldham has likened the former cry, which is uttered both while on the wing and when at rest, and which he renders as "tchek, tchek," to a diminutive of the alarm note of the greater spotted woodpecker.

Although easy to recognise when captured, the identification of this bat when on the wing is more difficult; but here again its size, fluttering flight, with frequent gliding intervals, and its light colour, are a combination of characters peculiar to the species.



LESSER HORSESHOE BATS. (Natural size.)